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A new species of reed snake, *Calamaria* Boie, 1827 (Squamata: Colubridae), from central Vietnam

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ABSTRACT.– **A new species of *Calamaria* Boie, 1827 is described, based on a single specimen collected in mixed secondary deciduous and bamboo forest at 1,200 m altitude from Kon Tum Province in Central Vietnam. The new species is characterized by rostral wider than high; preocular present; supralabials four; Supralabial II–III entering orbit; maxillary teeth nine, modified; infralabials 4–5, Infralabials I–III in contact with anterior chin shields; mental in contact with anterior chin shields; ventrals 2 + 190; subcaudal scales 19, divided; tail relatively short (6.2% of total length), as thick as body, not distinctly tapering, and ending in obtuse point; dorsum greyish-brown, with fine dark mottling; venter cream, with dark transverse bands and a dark longitudinal stripe below tail. This is the third new *Calamaria* taxon described from Vietnam in the past 15 years, and the sixth species recorded from this country. In addition, we provide a key to the Vietnamese species of *Calamaria*.**

KEY WORDS.– **Serpentes, *Calamaria*, taxonomy, Kon Tum Province, Vietnam.**

Introduction

The burrowing, forest-dwelling snake genus *Calamaria* Boie, 1827 is one of the most successful east Asian genera of colubrids. Reed snakes are distributed from eastern China and the Ryukyu Islands in the north, through Vietnam, Laos, Cambodia, Thailand and the Malay Peninsula to Myanmar in the west, and southward to Sulawesi, Seram and the Philippines. Despite its diversity, *Calamaria* exhibits a rather homogenous morphology. Based on the investigation of over 2,600 specimens, Inger & Marx (1965) recognized 50 species of *Calamaria*, of which nine new species or subspecies were described. Since the systematic review by these authors, five additional new taxa were recently described: *C. lovii ingermarxorum* Darevsky & Orlov, 1992 from central Vietnam; *C. ingeri* Grismer, Kaiser & Yaakob, 2004 from West Malaysia; *C. thanhi* Ziegler & Le, 2005 from central Vietnam; and *C. butonensis* Howard and Gillespie, 2007 and *C. longirostris* Howard and Gillespie, 2007,both from Buton Island, Indonesia.

During recent herpetological surveys in central Vietnam, the senior author found a dead snake on the ground. Although the specimen was in a somewhat desiccated state, morphological examination revealed it to be a representative of the genus *Calamaria* due to the following characters: dorsal scales in 13 rows throughout body, internasals and prefrontals fused, and parietal broadly in contact with supralabials (Inger and Marx, 1965). Because the specimen, collected in Kon Tum Province, was neither assignable to any of the reed snakes known from Vietnam nor to species reported from neighboring countries, we herein describe it as a new species.

Materials and Methods

The ethanol-preserved holotype is deposited in the Institute of Ecology and Biological Resources (IEBR), Vietnamese Academy of Science and Technology, Hanoi, Vietnam. Methods and comparisons follow Inger and Marx (1965), Darevsky and Orlov (1992) and Ziegler and Le (2005). Scale counts and further observations on external morphology were done by using a stereo dissecting microscope. Measurements were taken with a slide-caliper to the nearest 0.1 mm, except for body length, which was taken with a measuring tape. Ventral scales were counted after Dowling (1951).

Systematics

Calamaria sangi sp. nov.

(Figs. 1–6)

Holotype.– IEBR 360, an adult specimen (unknown gender) collected on 12 January 2001 by Nguyen Quang Truong and Andrei Kuznetsov from Mang Canh Commune (14°41.950'N, 108°14.642'E), Kon Plong District, Kon Tum Province, Vietnam; 1,200 m asl. (Fig. 7).

Diagnosis.– *Calamaria sangi* sp. nov. is distinguishable from congeneric species by having a combination of the following characters: 1) rostral wider than high; 2) paraparietal surrounded by five to six shields and scales; 3) eye diameter larger than eye-mouth distance; 4) preocular present; 5) four supralabials, second and third entering orbit; 6) maxillary teeth nine, modified; 7) infralabials four to five, first three touching anterior chin shields; 8) mental touching anterior chin shields; 9) ventrals 2 + 190; subcaudal scales 19, divided; 10) anal plate single; 11) tail relatively short (6.2% of the total length), as thick as body, not distinctly tapering, and ending in obtuse point; 12) dorsum greyish-brown, with fine dark mottling; 13) venter cream, with dark transverse bands and a dark longitudinal stripe below tail.

Description of holotype.– Rostral wider than high, portion visible from above shorter than prefrontal suture. Prefrontal shorter than frontal, not entering orbit, and touching first two supralabials. Frontal pentagonal to hexagonal, about two and a half times maximum width of supraocular. Paraparietal surrounded by five to six shields and scales. Preocular present, small. Postocular single, higher than wide, not as high as eye diameter (1.0 mm). Eye diameter larger than eye-mouth distance. Distance from anterior corner of eye to nostril 2.2 mm and to the tip of snout 3.7 mm. Pupil rounded. Four supralabials, second and third entering orbit, fourth longest, third about ¾ of second in length, first longer than third and as wide as second. Mental semicircular to triangular, touching anterior chin shields. Four to five infralabials, first three touching anterior chin shields. First pair of chin shields in contact mesially, second pair touching anteriorly and separated posteriorly, and third pair separated from each other by two gular scales (preventrals). Ventral scales 190; subcaudals 19, divided, followed by a shield covering tail tip. Anal scale single. Dorsal scales in 13 rows throughout body, reducing to six rows above eighth subcaudal, to five rows above 12th subcaudal, to four rows above 13th subcaudal, and to three rows above the last subcaudal on tail. Tail not distinctly tapering, ending in obtuse point.

Snout-vent length 350 mm.– tail relatively short, 23.3 mm in length (6.2% of the total length). Height of body 6 to 7 mm, height of tail at base 6 mm. Habitus vermiform, head indistinct from neck. Nine modified maxillary teeth.

Colouration in preservative.– Colour preserved in ethanol greyish-brown above, somewhat iridescent. Rostral brown. Upper parts of supralabials brownish, lower parts cream. Dorsal scales of body and head with fine dark mottling. Vertebral scales with small dark dots forming a longitudinal row on the posterior body. Two outermost dorsal scale rows on body and only outermost scale row on tail light cream, only margins partly dark pigmented. Each dorsal scale of tail at base with an indistinct light fleck; blunt tail tip dark with tiny light centre, surrounded by an indistinct thin yellow ring. The ventral side of the body cream; each ventral scale with dark pigmentation anteriorly resulting in pattern of narrow cross bands ventrally. Outermost corners of ventral scales dark, forming a thin, lateral zig-zag band. Venter of tail cream with a dark longitudinal stripe along the median sutures of the subcaudal scales. Subcaudals with fine dark dots on the anterior margins. The underside of the head whitish with a few brownish spots on the infralabials.

Comparisons.– Comparisons of the new species with congeners were made on material listed in Appendix 1 and from the literature (includ-

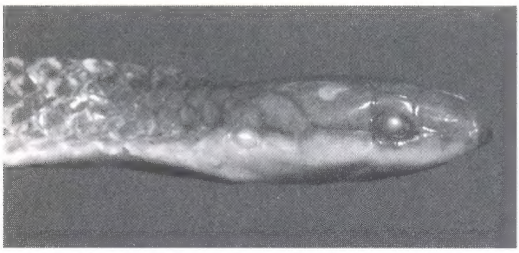

Figure 1. Lateral view of head of holotype of *Calamaria sangi* sp. nov. (IEBR 360).

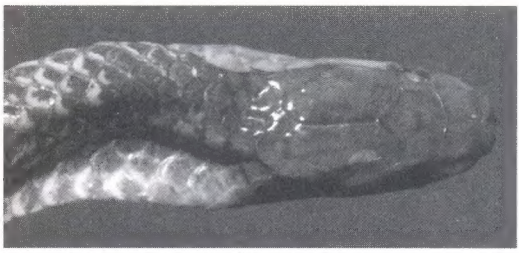

Figure 2. Dorsal view of head of holotype of *Calamaria sangi* sp. nov. (IEBR 360).

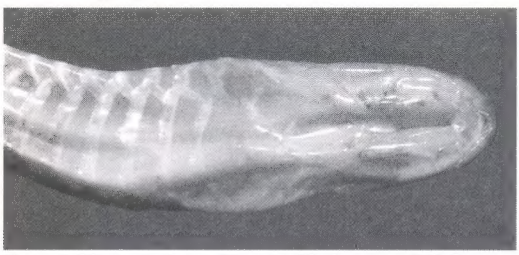

Figure 3. Ventral view of head of holotype of *Calamaria sangi* sp. nov. (IEBR 360).

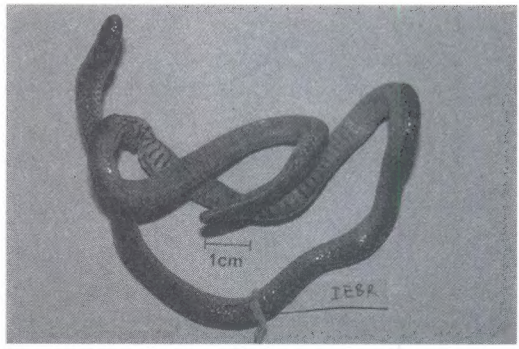

Figure 4. Overall view of holotype of *Calamaria sangi* sp. nov. (IEBR 360).

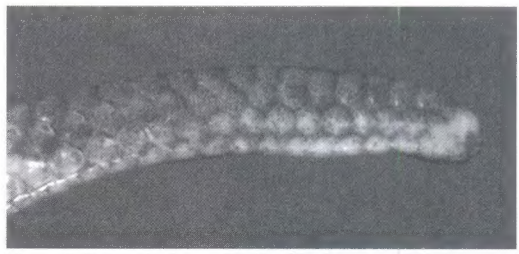

Figure 5. Lateral view of tail of holotype of *Calamaria sangi* sp. nov. (IEBR 360).

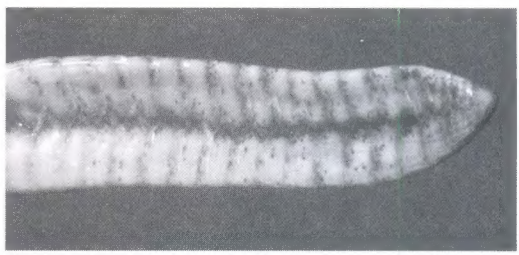

Figure 6. Ventral view of tail of holotype of *Calamaria sangi* sp. nov. (IEBR 360).

ing Smith, 1921, 1943; Bourret, 1936, 1937; Inger and Marx, 1965; Yang and Inger, 1986; Darevsky and Orlov, 1992; Ziegler and Le, 2005; Ziegler et al., 2007). We compared *Calamaria sangi* sp. nov. with *Calamaria* species from southern China and south-east Asia, that have four supralabials, i.e., *C. battersbyi* Inger and Marx, 1965; *C. borneensis* Bleeker, 1860; *C. buchi* Marx and Inger, 1955; *C. gracillima* (Günther, 1872); *C. javanica* Boulenger, 1891; *C. linnaei* Boie, 1827; *C. longirostris* Howard and Gillespie, 2007; *C. lovii* Boulenger, 1887; *C. melanota* Jan, 1862; *C. pavimentata* Duméril and Bibron, 1854; *C. schmidti* Marx and Inger, 1955; *C. septentrionalis* Boulenger, 1890; *C. thanhi* Ziegler and Le, 2005 and *C. yunnanensis* Chernov, 1962.

With respect to the remaining members of the genus from Vietnam, *Calamaria sangi* sp. nov. differs by its dorsal colour pattern: *C. buchi* is blackish above with each dorsal scale having small light spots and its ventral scales having dark outermost corners; *C. pavimentata* usually has narrow, dark, longitudinal stripes, and a solid black collar behind the neck; *C. septentrionalis* has dorsal scales with many small light dots forming a network; *C. lovii ingermarxorum* has an immaculate grey-bluish dorsum with light spots on each side of the neck covering four scales; *C. thanhi* has distinct transversal light body bands. The new species further differs from *C. buchi* by having fewer ventral scales (2 + 190 versus 221–236 in *C. buchi*). *Calamaria sangi* sp. nov. differs from *C. pavimentata* and *C. septentrionalis* by having the mental in contact with the anterior chin shields (usually separated in *C. pavimentata* and *C. septentrionalis*), tail ending in obtuse point

Table 1. Diagnostic characters of Vietnamese *Calamaria* (after Inger and Marx, 1965; Darevsky and Orlov, 1992; Ziegler and Le, 2005; and Ziegler et al., 2007); abbreviations: M - male, F - female; * - character unobtainable from literature.

	sangi sp. nov.	*buchi*	*pavimentata*	*septentrionalis*	*lovii ingermarxorum*	*thanhi*
Scalation						
Rostral	H < W	H > W	H ≥ W	H < W	H < W	H < W
Portion visible from above in comparison with length of prefrontal suture	> 1/2	> 1/2	1/2–1	< 1/3	>1/2	> 1
Comparison of the length between prefrontal and frontal	<	≤	≤	<	>	<
Number of shields and scales surrounding paraparietal	5–6	5	5–6	6	6	6
Preocular: present (1) or absent (0)	1	1	1	1	0	0
Comparison between eye diameter and eye-mouth distance	>	≤	≥	≥	*	>
Mental touching (1) or separated from (0) anterior chin shields	1	1	0	0	1	0
Posterior chin shields meeting in midline (1), diverging or meeting only anteriorly (0)	0	1	1	1	1	0
Tail: tapering (2), not distinctly tapering (1), or not (0)	1	1	2	0	0	2
End of tail	obtuse point	obtuse point	gradually to a point	broadly rounded	blunt	gradually to a point
Dorsal scales reduced to 4 rows above position of subcaudal on tail	1st-3rd subcaudal	3rd-4th subcaudal	1st-3rd subcaudal	not reduced	1st-5th subcaudal	not reducing to 4 rows
Maxillary teeth (modified = m)	9 (m)	9 (m)	8–10 (m)	8–9 (m)	8 (m)	9 (m)
Ventrals	2 + 190 (sex unknown)	221–236 (F)	125–168 (M) 137–206 (F)	148–166 (M) 168–188 (F)	205 (M)	198 (F)
Subcaudals	19	13–14 (F)	13–33 (M) 8–20 (F)	15–19 (M) 6–11 (F)	23 (M)	21 (F)
Total length	373.3	389–466 (F)	84–313 (M) 115–485 (F)	111–344 (M) 117–384 (F)	318 (M)	455 (F)
Ratio of tail length to total length (%)	6.2	3.9–4.1 (F)	6.9–16.9 (M) 3.7–8.5 (F)	6.3–8.6 (M) 2.6–4.3 (F)	7.4 (M)	6.8 (F)
Colouration (present - 1 or absent - 0)						
Dorsum	greyish- brown	blackish	brownish	dark brown or black	greyish- blue	dark blue to grey
Dorsal scales with light spots	0	1	0	1	0	0

Dark collar in nuchal region: distinct (1) or indistinct (0)	1	0	1	0	0	0
Yellow ring or blotches behind head	0	0	1	1	1	1
Transverse light body bands on dorsum	0	0	0	0	0	1
Light spots on each dorsal scale	0	1	*	1	0	*
Yellow ring around tip in tail	1	0	1/0	1	0	1
Outermost dorsal scale rows	yellow	yellow	dark line	yellow	*	yellow
Venter of body	yellow	yellow	yellow	yellow	dark grey	yellow
Underside of tail: dark longitudinal line (2), dark scattered spots/flecks (1), or absent (0)	2	1	2/0	2	0	1
Ventral scales with dark outermost corners	1	0	0	1	0	0
Ventral scales with dark pigmentation anteriorly	1	0	0	0	0	0

(tail tip with sharp point in *C. pavimentata* and rounded in *C. septentrionalis*). The new species further differs from *C. pavimentata* by having dorsal scale rows reduced to three rows towards terminal scute (versus four or rarely five in *C. pavimentata*), and having ventral scales with dark outermost corners (absent in *C. pavimentata*). The three taxa *C. pavimentata banaensis* Bourret, 1934, *C. pavimentata annamensis* Bourret, 1937, and *C. pavimentata uniformis* Smith, 1921, which were described from central Vietnam, were synonymized with *C. pavimentata* by Inger and Marx (1965), because none of their characters (mainly differences in colour pattern) were in fact diagnostic. However, *Calamaria sangi* sp. nov. is distinguished from the three afore mentioned forms by having indistinct light blotches on dorsal tail base (absent in all the afore mentioned forms from central Vietnam) and ventral scales 2 + 190 (versus 143–167 in *C. pavimentata uniformis*, 157–179 in *C. p. banaensis*, and 205 in *C. p. annamensis*) (see Smith 1921, Bourret 1936, 1937).

Calamaria sangi sp. nov. differs from *C. lovii* and *C. thanhi* by having a preocular scale (absent in both latter species). It further differs from *C. lovii ingermarxorum* by having prefrontals shorter than frontal. Compared with the subspecies of *C. lovii,* which do not occur in Vietnam, the new species differs from *C. lovii wermuthi* by having 2 + 190 ventrals and 19 subcaudal scales (versus 256 and 11 in *C. l. wermuthi*) and from *C. lovii gimletti* by having the mental in contact with the anterior chin shields (separated in *C. l. gimletti*). *C. yunnanensis*, a species reported from southern China, was judged as doubtful form by Inger and Marx (1965), but subsequently listed as valid by Yang and Inger (1986) and Zhao and Adler (1993). *Calamaria sangi* sp. nov. differs from the latter by having a higher ventral count (2 + 190 vs. 173), lower ratio of tail length/total length 0.062 (versus 0.082), and lacking narrow, dark, elongated stripes along the body. *Calamaria sangi* sp. nov. differs from *C. gracillima*, *C. javanica*, *C. longirostris*, and *C. schmidti* by having a preocular (that is absent in all latter species). The new species differs from *C. battersbyi*, *C. linnaei*, and *C. melanota* by having a higher ventral count (2 + 190 versus 171 in *C. battersbyi*, 130–166 in *C. linnaei*, and 121–154 in *C. melanota*). The new species differs from *C. borneensis* by lacking one to three yellow rings around tail (which are present in *C. borneensis*).

Distribution and habitat.– The holotype was found dead on the forest floor near Nuoc Ka Stream at an altitude of 1,200 m asl. The habitat consisted of mixed secondary deciduous and bamboo forest (Fig. 8).

Etymology.– Named *sangi* to honor Nguyen Van Sang (Institute of Ecology and Biological Resources, Vietnam-

ese Academy of Science and Technology, Hanoi, Vietnam) in recognition of his lifework. As common names we suggest Sang's reed snake (English), Ran mai gam sang (Vietnamese), Calamaire de Sang (French), and Sangs Zwergschlange (German).

Discussion

Except for *C. pavimentata* and *C. septentrionalis*, which both are relatively well known and which have already been recorded from numerous localities in Vietnam, *Calamaria buchi*, *C. lovii ingermarxorum*, and *C. thanhi* are known to date only from a few specimens collected in a single province each (Darevsky and Orlov, 1992; Orlov et al., 2003; Ziegler and Le, 2005; Ziegler et al., 2007). The discovery of *Calamaria sangi* sp. nov. argues once more for the rareness of certain *Calamaria* species. The large distribution range of *C. pavimentata* from western Myanmar to Ryukyu Islands and south to the Malaysian Peninsula, together with wide ranging scale counts and scale patterns (Inger and Marx, 1965) could point to hidden diversity (see also Ziegler and Le, 2005), which cannot be dealt with in this paper. However, this observation deserves further attention (see Ota and Hokama, 1996) especially as it is well documented that certain *Calamaria* species tend to be locally restricted (e.g., Tweedie, 1961). Ota (1982) tentatively regarded *C. pfefferi* Stejneger, 1901 from the Ryukyu Islands, Japan, as a

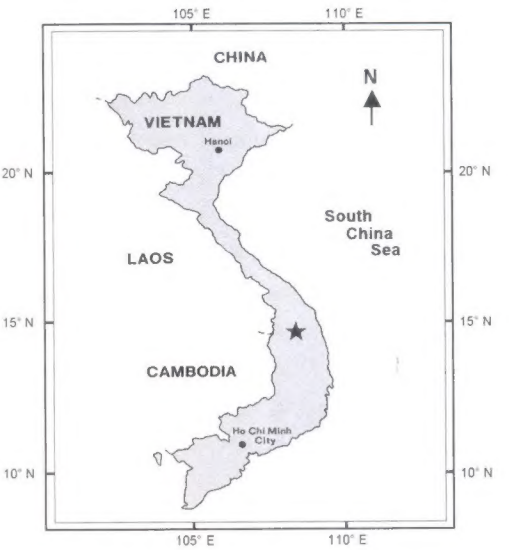

Figure 7. Map showing the type locality of *Calamaria sangi* sp. nov. in Kon Tum Province, central Vietnam.

Figure 8. Habitat of *Calamaria sangi* sp. nov. in Kon Plong, Kon Tum Province, central Vietnam.

valid species (see Mori, 1984), although it was treated by Inger and Marx (1965) as a synonym of *C. pavimentata*. *Calamaria sangi* sp. nov. is the 56th known species of reed snake and the sixth species of *Calamaria* recorded from Vietnam. A key to the species of *Calamaria* from Vietnam is presented below.

Key to the species of *Calamaria* known from Vietnam (after Inger and Marx, 1965; Darevsky and Orlov, 1992; Ziegler and Le, 2005; Ziegler et al., 2007):

1a Preocular absent 2
1b Preocular present 3
2a Dorsum bluish grey with light spots covering four scales on each side of the neck; mental touching anterior chin shields; 205 ventral; 23 subcaudals . . . . . .*C. lovii ingermarxorum*
2b Dorsum dark with 4–6 light body bands; mental separated from anterior chin shields; 184 ventrals; 28 subcaudals . . . . . *C. thanhi*
3a Tail tapering with rounded end . . . . . *C. septentrionalis*
3b Tail not (distinctly) tapering, ending in obtuse or sharp point 4
4a Dorsum black, dorsal scales with light spots; 221–236 ventrals . . . . . *C. buchi*
4b Dorsum greyish brown or brown, dorsal scales without light spots; 125–206 ventrals. 5
5a Mental usually separated from anterior chin shields; ventral scales without dark outermost corners and dark pigmentation anteriorly; tail tip with sharp point. . . . . *C. pavimentata*
5b Mental in contact with anterior chin shields; ventral scales with dark outermost corners and dark pigmentation anteriorly; tail tip with obtuse point . . . . . *Calamaria sangi* sp. nov.

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Appendix 1

Comparative specimens examined

Calamaria pavimentata: VIETNAM: IEBR 57, 58 from Central Vietnam; ZFMK 81444 from Ky Anh – Ke Go, Ha Tinh Province. *Calamaria septentrionalis*: VIETNAM: IEBR 68 from Central Vietnam, A.0715 from Central Vietnam. *Calamaria thanhi*: VIETNAM: ZFMK 82920 (Holotype) from Phong Nha – Ke Bang, Quang Binh Province.

NOTE ADDED IN PROOF

While the current paper was in press, two other *Calamaria* species have been described from Vietnam: *Calamaria gialaiensis* Ziegler et al. (2008) and *Calamaria abramovi Orlov* (2009).

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Miscellanea Herpetologica Gabonica III

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ABSTRACT.– ***Dasypeltis confusa*** **(Colubridae) is reported for the first time from Gabon.** ***Bitis arietans*** **(Viperidae) is confirmed for Gabon.** ***Natriciteres variegata*** **(Natricidae) is withdrawn from the Gabon reptile list. New localities and/or ecological data are provided for** ***Hemidactylus angulatus*** **and** ***H. richardsonii*** **(Gekkonidae),** ***Crotaphopeltis hotamboeia***, ***Philothamnus dorsalis***, ***Thrasops flavigularis*** **(Colubridae),** ***Naja melanoleuca*** **(Elapidae),** ***Aparallactus modestus***, ***Atractaspis reticulata***, ***Hormonotus modestus***, ***Mehelya capensis*** **(Lamprophiidae) and** ***Bitis gabonica*** **(Viperidae). Six species are newly recorded from Haut-Ogooué Province.**

KEYWORDS.– **Reptilia, Gekkonidae, Colubridae, Elapidae, Lamprophiidae, Natricidae, Viperidae, Haut-Ogooué, Gabon.**

Introduction

Due to the scarcity of data on the distribution and ecology of the herpetofauna of Gabon, we decided to make relevant new observations available through a series of publications entitled *Miscellanea Herpetologica Gabonica* (see Pauwels and David, 2008a–b), of which the present article is the third part. One of the main objectives of the series is to evaluate literature and museum records to help establish a documented list of the reptiles of the country.

Material and methods

Within squamate suborders and families, taxa are presented in alphabetical order in the Results. Specimens were collected by BS (Franceville), Didier Lanteri (Port-Gentil) and OSGP (other localities). New locality records are marked with an asterisk (*), new department (district) records by two asterisks (**), and new province records by three asterisks (***). Body measurements were made to the nearest millimeter. Paired meristic characters are given in left/right order. Snake ventral scales were counte according to Dowling's (1951) method. The te minal tail scute is not included in the subca dal count. The numbers of dorsal scale rows a given respectively at one head length behi head, at midbody (above the ventral correspon ing to half of the total number of ventrals), a at one head length before vent. Numbers of s pralabials are followed between brackets by t indication of which among them border the e Numbers of infralabials are followed betwe brackets by the number among them borderi the first pair of sublinguals. The sex of snal was determined by tail dissection.

Abbreviations: Institutions: CECBG: Cer d'Etude et de Conservation de la Biodiver de l'Institution Smithsonian, Vembo, Gan CIRMF: Centre International de Recher Médicales, Franceville; MNHN: Muséum tional d'Histoire naturelle, Paris; USNM: tional Museum of Natural History, Washin D.C. Morphology: DSR: dorsal scale row(s infralabial scale(s); Lor: loreal scale(s); postocular scale(s); PreO: preocular sca

PV: preventral scale(s); SC: subcaudal scale(s); SL: supralabial scale(s); SVL: snout-vent length; TaL: tail length; Tem: temporal scale(s); TL: total length; VEN: ventral scale(s). Others: Dept.: Department; Prov.: Province.

Results

Gekkonidae

Hemidactylus angulatus Hallowell, 1852

An adult female (USNM 565130; SVL 67mm; partly regenerated tail 67 mm) was caught by day on 21 May 2007 on a building wall at Terminal*, Gamba*, Ndougou Dpt.**, Ogooué-Maritime Prov. It has unwebbed fingers and toes, numerous dorsal tubercles separated by a distance comparable to their own diameter, widened median SC, and an uninterrupted series of 29 poreless, enlarged preano-femoral scales. Two other specimens, an adult and a subadult, were caught at the same locality in 2006 and 2007, living in syntopy with large numbers of *Hemidactylus mabouia*. *Hemidactylus angulatus* was described from Gabon, without further details of the collecting locality (Hallowell, 1852). The 19th century definition of Gabon, however, was quite different from that of today. The only precise locality that was so far known from Gabon, Port-Gentil, also in Ogooué-Maritime Prov., was provided by Pasteur et al. (1978, under *H. brooki* [sic]). Gamba is, like Port-Gentil, a locality with intense air and sea traffic, and it is not yet sure if the species is indigenous to Gabon.

Hemidactylus richardsonii (Gray, 1845)

An adult individual (USNM 565131; SVL 76 mm; TaL 75 mm) was caught in July 2005 in the Vera Plains*, near Gamba, Ndougou Dpt., Ogooué-Maritime Prov. This specimen was caught by day under the bark of an isolated, burnt, dead tree in a savanna. It was ca. 1.5 m above the ground. It shows a longitudinal skin fold along the base of the flanks, a flattened tail with lateral spines, widened median SC, 46 enlarged preano-femoral scales, and webbed fingers and toes. This species is known in Gabon from only a few specimens, all caught in primary or dense secondary forest, as is typical for the species (see a.o. Spawls et al., 2002). Its presence in both savanna and forest suggests that it may have a much wider distribution in the country.

Colubridae

Crotaphopeltis hotamboeia (Laurenti, 1768)

An adult male specimen (USNM 565132; SVL 464 mm, TaL 75 mm) was caught in the CIRMF compounds, Franceville*, Passa Dpt.**, Haut-Ogooué Prov.***, on 27 August 2003. It has a vertical pupil, 8(3–5)/8(3–5) SL, 10(5)/9(4) IL, 1/1 Lor, 1/1 PreO, 2/2 poO, 1+2/1+2 Tem. Additional meristic characters are shown in Table 1.

Dasypeltis confusa Trape and Mané, 2006

A subadult female (USNM 565133; SVL 369 mm; TaL 58 mm) was collected in 2005 in Port-Gentil*, Bendjé Dpt.**, Ogooué-Maritime Prov.*** It has keeled DSR; 7(3–4)/7(3–4) SL, 7(3)/7(2) IL, 0/0 Lor, 1/1 PreO, 2/2 PoO, 2+4/2+4 Tem (see also Table 1). Fifty-seven roundish mediodorsal spots follow the nuchal band; nearly all of them are connected to lateral vertical bands to form the pattern typical of *D. confusa* (see Trape and Mané, 2006). A subadult male (USNM 565134; SVL 356mm; TaL 72mm) was caught at CIRMF*, Franceville*, Passa Dpt.**, Haut-Ogooué Prov.***, on 20 April 2007. It shows 0/0 Lor, 1/1 PreO, 1/1 PoO (the superior postocular is fused with the supraocular), 2+4/2+4 Tem. It has 61 mediodorsal spots and shows the same pattern as the previous specimen. Both have a vertical pupil and all dorsal scales keeled. The report by Gans (1959:154, 233) of *Dasypeltis scabra* (Linnaeus, 1758) from "Achouka, Bas Ogooué" based on MNHN 94–177 is referable to *D. confusa* (D. G. Broadley, pers. comm., May 07). All former records of *Dasypeltis scabra* from Gabon are probably assignable to *D. confusa*.

Philothamnus dorsalis (Barboza du Bocage, 1866)

An adult female (USNM 565135; SVL 462 mm; TaL 230 mm) was collected in 2005 in Port-Gentil*, Bendjé Dpt.**, Ogooué-Maritime Prov. It has smooth DSR, laterally keeled VEN and SC; a round pupil; 9(4–6)/9(4–6) SL; 10(5)/10(5) IL, 2 pairs of sublinguals; 1/1 Lor,

1/1 PreO, 2/2 PoO, 1+1+1/1+1+1 Tem. It has two post-parietals in contact behind a small median scale. In alcohol, its back is bronze-grey with a dark brown vertebral band. For other characters, see Table 1.

Thrasops flavigularis (Hallowell, 1852)

An adult male (CECBG no nr; SVL 1102 mm; TaL 481 mm) was collected in 2003 in the CIRMF compounds*, Franceville*, Passa Dpt.**, Haut-Ogooué Prov.*** It has 1/1 Lor, 1/2 PreO, 3/3 PoO, 8(4–5)/8(4–5) SL, 11/12 IL, 1+1/1+1 Tem, and a round pupil; see also Table 1. Each of the IL of the first pair is divided into two scales, an anterior and a posterior one, thus forming an additional pair of sublinguals (and hence a total of three pairs). All DSR are slightly keeled. VEN are laterally slightly keeled; SC are unkeeled laterally.

Elapidae

Naja melanoleuca Hallowell, 1857

An adult specimen was killed in 2006 in the compounds of the CIRMF, and only the head was preserved (USNM 565136). It shows no Lor, 7(3–4)/7(3–4) SL, 8(4)/8(4) IL, 2 pairs of sublinguals, 1/1 PreO, 3/3 PoO, 1/1 anterior temporal, 2 PV and a round pupil. Its dorsals are slightly keeled on the posterior body part. The species was recently recorded from the same locality and for the first time from Haut-Ogooué Prov. (Pauwels et al., 2007), but was vouchered only by a photograph.

Lamprophiidae

Aparallactus modestus (Günther, 1859)

A subadult male (USNM 565137; SVL 241 mm; TaL 57 mm) was killed at CIRMF*, Franceville*, Passa Dpt.**, Haut-Ogooué Prov.***, on 3 March 2007. It has 7(3–4)/7(3–4) SL, 7(4)/7(4) IL, 0/0 Lor, 1/1 PreO, 2/2 PoO, 0+1/0+1 Tem. To the VEN number shown in Table 1, a half-VEN must be added, situated on the left side between the last VEN and the anal. The pupil is round. DSR, VEN and SC are unkeeled.

Atractaspis reticulata Sjöstedt, 1896

We collected an adult male specimen (USNM 565138; SVL 730 mm; TaL 45 mm) while it was crossing a road at 10 p.m. in a swampy secondary forest on 5 February 2007 in Yenzi*, Gamba*, Ndougou Dpt.**, Ogooué-Maritime Prov.*** This locality is situated a few hundred meters from the sea, and a few meters above sea level. This specimen and its biotope were illustrated by Dobiey and Vogel (2007:29). The snake was not aggressive when caught. Its characteristics are as follows: eye mall (about same size as PoO); rostral visible from above; 2 internasals, in median contact; 2 prefrontals, in median contact; frontal large, about as wide as long; 1/1 supraocular; 5/5 SL, 3rd and 4th contact the eye, 4th the largest; 3rd SL widely in contact with prefrontal on each side; eye in contact with the supraocular, the prefrontal, the 3rd and 4th SL and the PoO; 1+2/1+2 Tem; 5/5 IL; first pair of IL in contact behind the small mental; 2nd pair of IL in contact (or can also be interpreted as a fusion between the 2nd IL and the first and only a pair of sublinguals on each side); 3rd IL very elongated; DSR smooth; vertebral row not enlarged; VEN and SC laterally unkeeled. Other meristic characters are given in Table 1. Fangs are long and erectile. Hemipenes partly everted. The whole animal is black, except the mental shield which is whitish. This specimen represents the second record of this rare species for Gabon. It has been recorded from Makokou, Ogooué-Ivindo Prov., northeastern Gabon (Knoepffler, 1966:20, as *Atractaspis reticulata heterochilus*). The latter locality is situated at ca. 500 m asl. Given their meristic characters, both Knoepffler's and our specimens should be identified as *A. reticulata heterochilus* Boulenger, 1901 using the key provided by Perret (1960), but there is no current consensus on the validity of this subspecies.

Hormonotus modestus (Duméril, Bibron and Duméril, 1854)

A subadult male (USNM 565139; SVL 476 mm; TaL 136 mm) was caught by day at CIRMF*, Franceville*, Passa Dpt.**, Haut-Ogooué Prov.*** on 11 January 2007. It shows 8(3–5)/8(3–5) SL, 8(4)/9(5) IL, 1/1 Lor, 1/1 PreO, 3/3 PoO, 2+3/2+3+3 Tem. VEN are laterally keeled. DSR are smooth; the vertebral row is enlarged. The pupil is vertically elliptical. Other characters are given in Table 1.

Table 1. Meristic characters for some Gabon snakes. Taxa are arranged by alphabetical order.

Species	Collection number	Sex	DSR	PV+VEN	An	SC
Aparallactus modestus	USNM 565137	M	15–15–15	1 + 133	Single	44, undiv.
Atractaspis reticulata	USNM 565138	M	19–23–19	4 + 318	Divided	2 div. + 1 undiv. + 26 div.
Bitis arietans	USNM 565141	M	?–30–20	ca. 4 + 144	Single	28, div.
Bitis gabonica	USNM 565142	F	?–40–29	3 + 135	Single	22, div.
Crotaphopeltis hotamboeia	USNM 565132	M	17–19–15	1 + 175	Single	44, div.
Dasypeltis confusa	USNM 565133	F	26–25–21	1 + 210	Single	55, div.
	USNM 565134	M	23–22–19	1 + 197	Single	64, div.
Hormonotus modestus	USNM 565139	M	15–15–13	2 + 232	Single	96, div.
Philothamnus dorsalis	USNM 565135	F	15–15–11	1 + 178	Divided	119, div.
Thrasops flavigularis	CECBG no nr	M	17–15–12	2 + 201	Divided	142, div.

Mehelya capensis (Smith, 1847)

An adult individual (USNM 565140) was killed by machete at the CIRMF*, Franceville*, Passa Dpt.**, Haut-Ogooué Prov., on 13 April 2007 and only the head and fore neck were preserved. It shows a vertical pupil, 7(3–4)/7(3–4) SL, 8(4)/8(5) IL, 2 pairs of sublinguals, 1/1 Lor, 2/2 PreO, 3/3 PoO and 1+2+3/1+2+3 Tem. Its dorsals are strongly keeled, showing well-developed secondary keels. The keels are also present on the temporals. Each scale of the vertebral row has a pair of longitudinal parallel keels. The head scalation and keeling are similar to those of the illustration of the type of *Mehelya savorgnani* by Mocquard (1887:pl. 2). The status of the latter taxon, especially its distinctiveness from *Mehelya capensis*, is unclear. It was treated by Chippaux (2006) as a subspecies of *M. capensis*, but showing a wide sympatry with the nominal subspecies. The three differences between both subspecies presented by Chippaux (2006) concern the number of VEN and SC, with important overlaps, and a subtle difference in the colouration of the vertebral row scales, with a light spot situated on a basal position on each scale in the subspecies *savorgnani* and a median position in the subspecies *capensis*. Chippaux (2006) also mentioned the existence of two colour morphs in the subspecies *savorgnani*: one without light spots on the vertebral row scales, another with light spots on the extremity of the dorsals. Until a revision is undertaken resulting in clear characters separating these forms, we prefer to regard *M. capensis* and *M. savorgnani* as synonyms.

Natricidae

Natriciteres variegata (Peters, 1861)

Frétey and Blanc (no date) listed *N. variegata* from Gabon based on the record by Waardenburgh and Guicherit (1991:table 1) (T. Frétey, pers. comm.) from Ofoubou (also known as Moufoubou), Ndolou Dept., Ngounié Prov. Waardenburgh and Guicherit (1991:41) wrote that it was locally the most common snake and they vouchered their record with a colour picture showing the left side of the head and forebody of what is obviously a *N. fuliginoides*, indeed the most common sylvicolous snake species in southwestern Gabon. The picture shows a.o. a divided nasal scale, 8(4–5) black-edged SL, 1 Lor, 1 PreO, 3 PoO, 1 anterior Tem, a round black pupil, an orange iris and a yellow throat. *Natriciteres variegata* can thus be at least provisionally deleted from the Gabon reptile list. On his distribution map for this species, Chippaux (2006) put a question mark on Gabon.

Viperidae

Bitis arietans (Merrem, 1820)

A juvenile specimen (USNM 565141; SVL 364 mm; TaL 39 mm) was collected in 2006 at the CIRMF*, Franceville*, Passa Dpt.**, Haut-Ogooué Prov. It was killed with a machete, and a few of the throat VEN are missing. Its DSR are strongly keeled. It has a vertical pupil, dorsally-oriented nostrils, 12/13 SL, not in contact with the eyes, 15(4)/15(4) IL, a pair of sublinguals, and 8 scales between the eyes. Additional

meristic characters are shown in Table 1. This species was not listed for Gabon by Frétey and Blanc (no date). Pauwels et al. (2006), however, listed it for Gabon based on unvouchered records made by two naturalists (J. Maran and P. Christy) in Haut-Ogooué Prov. (Djouori-Agnili Dpt.) and in Moukalaba-Doudou National Park. The species is thus presently confirmed for the country.

Bitis gabonica (Duméril, Bibron and Duméril, 1854)

A juvenile female (USNM 565142; SVL 342 mm; TaL 26 mm) was found at the CIRMF*, Franceville*, Passa Dpt.**, Haut-Ogooué Prov.***, on 12 June 2003. It was killed by a machete and some neck scales are missing. It shows 15(0)/15(0) SL, 18(5)/19(6) IL and a vertical pupil. The eyes are surrounded by 15/16 small scales and are dorsally separated by 13 scales. All its DSR are keeled. Additional characters are presented in Table 1. It thus occurs at the CIRMF syntopically with *Bitis arietans*.

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Monitoring of *Python molurus molurus* in Keoladeo National Park, Bharatpur, Rajasthan

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(with three text-figures)

ABSTRACT.– **The Indian rock python, *Python molurus molurus* population in the Keoladeo National Park (KNP), Bharatpur, Rajasthan was monitored from December 1999 to April 2000. Surveys were conducted at 10 days intervals to record basking pythons near their burrows. No significant change in the estimated number of pythons was found since the last study in 1986–87. Despite nine new burrows, the total number of python burrows has dwindled due to inundation of the park area, porcupine poaching or natural causes. Disturbance by tourists was the highest in those burrows where sighting was frequent, number of pythons greater, and where the access was easy. We suggest some measures for the conservation of pythons in KNP.**

KEY WORDS.– **Population monitoring; conservation; *Python molurus*; Keoladeo National Park, India.**

Introduction

Monitoring populations of endangered wild biota is crucial to our conservation goals. The information gathered from such exercises is essential for the development and implementation of policies tailored to meet local conditions. Populations can be monitored periodically by conducting inventories, surveys, or demographic and viability studies. As humans intrude upon species and habitats, the need to make well-informed management and conservation decisions heightens the need for more such studies into their status (Reinert and Rupert, 1999). The Indian python is distributed throughout most of the Indian subcontinent, its range extending from Sind and Punjab in Pakistan to Assam in India to the North, and southward throughout the Indian peninsula and Sri Lanka (Smith, 1943). It occupies a wide range of habitats from dry and rocky scrub to moist forests. This species has been listed in Schedule I of the Indian Wildlife Protection Act 1972, and it was listed under CITES subsequent to severe habitat loss and abuse by the skin, pet, and meat trade (Whitaker, 1993).

In India, the python population at Keoladeo National Park (KNP) has been the only one subjected to monitoring (Bhupathy and Vijayan, 1989). The species is known to cohabit with the Indian porcupine, *Hystrix indica* in ground burrows (Bhupathy and Haque, 1986). An estimate of the python population was last conducted in 1986–87 (Bhupathy and Vijayan, 1989); at the time, a study was conducted to identify individual snakes using variations in the natural markings (Bhupathy, 1990). Similar method was used by the Madras Crocodile Bank Trust to monitor the pythons released in the wild (R. Whitaker, pers. comm.).

In KNP, this species has a unimodal diurnal activity pattern during the winter and a bimodal crepuscular activity pattern during the summer (Bhatt and Choudhury, 1993). During the winter, the temperature falls to a low of 4°C at night and rises to about 23°C during the day. This low ambient temperature stimulates this large-bodied

snake to thermoregulate by basking (Bhatt and Choudhury, 1993). In the present study, we present monitoring data for the python population in KNP and suggest plausible management options.

Study area

The Keoladeo National Park (KNP), Bharatpur, India (27°7.6′–27°12.2′ N and 77°29.5′–77°33.9′ E) is known for large concentrations of migratory waterfowl. The total area is 29 km^2, including about 8.5 km^2 of wetland. The area of the wetland depends on the water released from a nearby reservoir during the monsoon season (Vijayan, 1991). Agricultural land surrounds KNP on all sides, with the town of Bharatpur in the north. The KNP has a network of embankments defining the area into sectors (Fig. 1) that enable easy access to the deeper areas by forest managers and tourists. The soil around the python area is saline and the vegetation is dry mixed deciduous Babul forest (Bhupathy and Vijayan, 1989; Champion and Seth, 1968). Vegetation adapted to semi-arid conditions, such as *Prosopis juliflora* and *Salvadora* sp., are common in KNP.

Field methods

In KNP, pythons thermoregulate during the winter by basking diurnally. The method used by Bhupathy and Vijayan (1989) was followed for data collection during the present study. The study area was extensively surveyed on foot during mid December 1999, and probable python burrows were marked on a map. A ground burrow was considered to be a python burrow when live snakes or signs of their presence (body marks, sloughs, scats) were seen nearby. These burrows were surveyed once in 10 days (both forenoon and afternoon) from 20 December 1999 to 10 April 2000 subsequent to a preliminary survey during mid December 1999. Number of snakes observed at each burrow was recorded. The maximum number of sightings of pythons at a given burrow during various surveys was regarded as the number of snakes dwelling there. The sum of this figure from all burrows accounted for the population (Bhupathy and Vijayan, 1989). Size of the snake was estimated visually whenever possible. Changes in the burrow system and new burrows were also noted.

Results

Python burrows.– During the present study, 22 python burrows were identified in the whole terrestrial area of KNP. Thirteen of these existed during the study by Bhupathy and Vijayan (1989), whereas nine new burrows have been formed in the intervening period. However, the distribution of pythons and their burrows have changed since 1986–87 (Fig. 1). This change was due to an increase in water input in 1992–93 that resulted in the inundation of many burrows. A total of 25 burrows were lost to the inundation since the report of Bhupathy and Vijayan (1989, Table 1).

Python status.– Including the preliminary surveys during mid December 1999, a total of 506 visits were made to python burrows (22 burrows x 23 visits) and 743 snakes were sighted from 20 December 1999 to 10 April 2000. The number of pythons estimated in KNP was 112 (Table 1). This figure is not significantly different ($F = 0.027$, $p < 0.871$) from that of the study during 1986–87. However, we expect

Table 1. Comparison of the status of pythons and their burrows in Keoladeo National Park, Bharatpur during 1986–87 and 1999 –2000; For description on sectors, see Vijayan (1991).

Sector	1986 – 87		1999 – 2000		Burrows Lost
	No. of Burrows	No. of Pythons	No. of Burrows	No. of Pythons	
A	5	11	5	7	2
B	5	15	1	2	5
C	2	13	1	15	1
F	4	20	2	14	3
G	1	3	0	0	1
H	3	2	2	7	1
I	5	15	3	34	2
K	3	14	1	3	3
M	3	6	3	16	1
N	1	0	1	1	0
O	6	6	3	13	6
Total	38	105	22	112	25

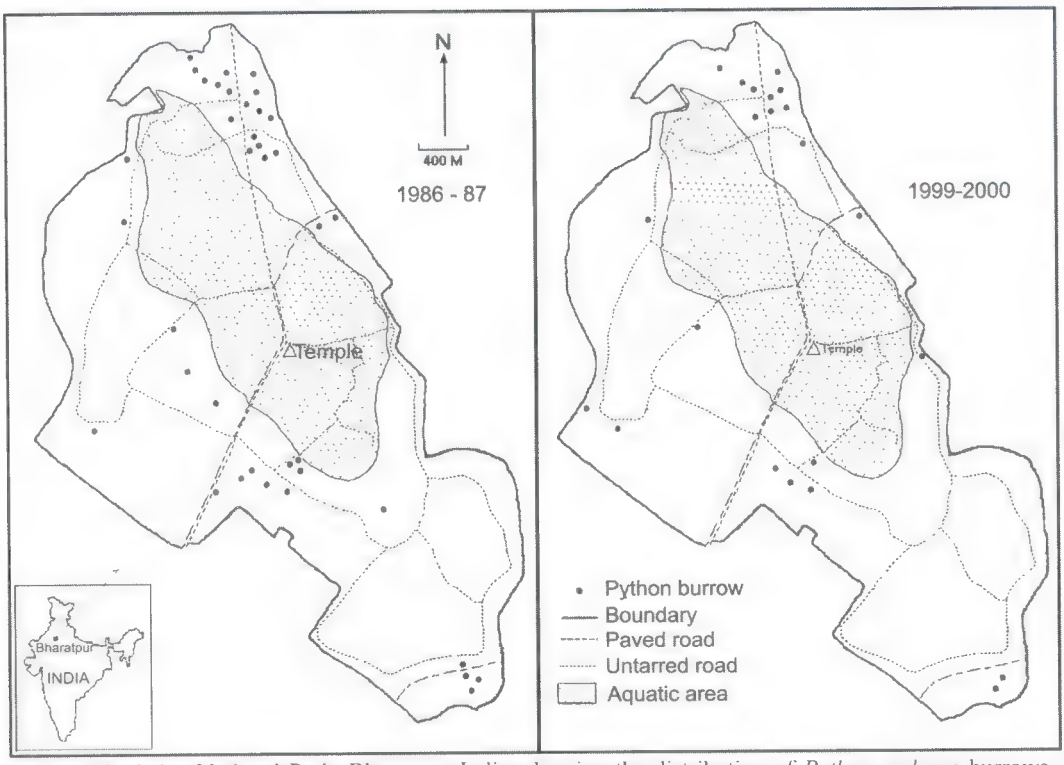

Figure 1. Keoladeo National Park, Bharatpur, India, showing the distribution of *Python molurus* burrows during 1986–87 and 1999–2000.

the actual number to be higher as this is only an index and the method has certain inherent problems (Bhupathy and Vijayan, 1989). Pythons used the burrows communally, and at a time more than 10 pythons were observed near some burrows. The number of pythons per burrow increased from that of the previous study (5 snakes/ burrow in 1999–2000, 2.76 snakes/ burrow in 1986–87). It is quite probable that pythons moved into the occupied burrows nearby when their burrows collapsed or were inundated.

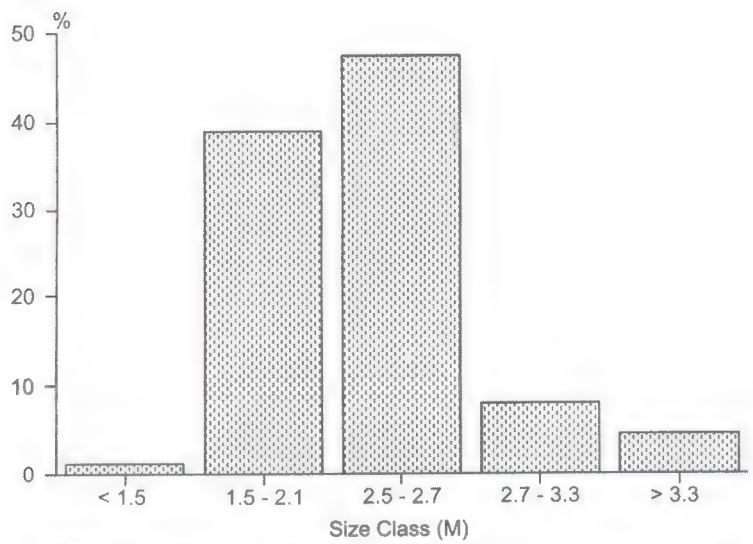

Figure 2. Size structure of *Python molurus* in Keoladeo National Park, India during 1999–2000 (n = 239).

Of the 743 observations of pythons during this study, length data for 239 could be recorded. Pythons in KNP showed unimodal distribution pattern (Fig. 2). Pythons measuring over 3.3 m (11 F) contributed only 4.6% of the tota! observations, which indicates the rarity of larger snakes in the population.

Conservation problems.– Porcupine hunting, fluctuating water levels and disturbance by tourists are major threats to pythons

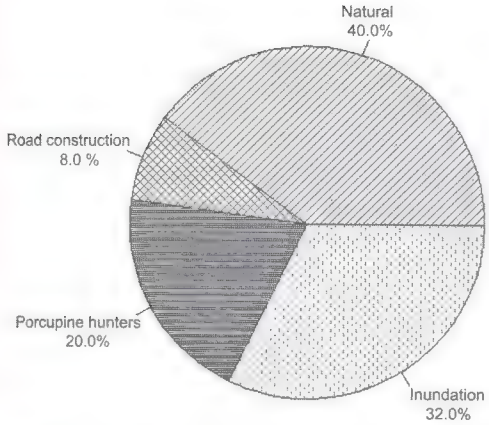

Figure 3. Factors associated with loss of burrows of *Python molurus* in Keoladeo National Park, India.

in KNP. Anthropogenic reasons including, inundation of burrows, porcupine hunting and road construction accounted for about 60% of burrow loss (Fig. 3).

Porcupines are hunted for food. Hunting was confirmed by the presence of canals extending into the openings of burrows. These canals divert water from rain pools into the burrows. As the burrows fill up, emerging porcupines are killed. Burrow loss due to this reason from 1987 to the time of our study is 20% (n = 25). Tourism in KNP is highest during winter, corresponding with frequent sightings of basking pythons and the visiting migratory waterfowl. Tourists are seen walking around the pythons and burrows, approaching them from all directions. Firewood and grass collectors inadvertently disturb burrows located on trails leading to villages. Python burrows visited by tourists account for about 70% of the population in KNP.

Water is supplied to KNP by the State Irrigation Department during every monsoon. Two decades of data show that the water input was at maximum in 1992–93 (16.53×10^6 m^3) and lowest in 1997–98 (0.07×10^6 m^3). From 1993–'99 water levels reduced regularly, and in 1998–99, water input was only 9.91×10^6 m^3. However, it was observed that during 1998–99, the inundated area of the park was higher than any in the past 20 years. Whereas the fluctuating water levels were lower than in 1992–93, the increase in water spread may be explained by a decrease in the water holding capacity (depth) of the wetland. As the depth of the wetland is reduced, most of the python burrows distributed near the aquatic area were lost due to inundation.

Discussion

Monitoring of pythons in India has so far only been done in KNP. For monitoring, this study repeated the work of Bhupathy and Vijayan (1989) after 13 years. Turnover of burrows has been considerable, such that only about a third of them (13 of 38) from the previous study existed during this study. The type of soil, vegetation, anthropogenic activity, porcupine activity, and the number of resident snakes is important in determining the longevity of the burrows. Higher density of pythons per burrow (5 snakes/ burrow in 1999–2000; 2.76 snakes/ burrow in 1986–87) may result in over-crowding; this in turn may increase aggressive encounters among pythons (Barker et al., 1979) and other species such as porcupines sharing the burrows. It has been demonstrated that greater number of individuals in a burrow can affect the thermal profile of the aggregation (Graves and Duvall, 1987); this may influence the activity pattern of the pythons and their interactions with associated animals within the burrow, the consequences of which are unknown.

Porcupines largely maintain the python burrows (structure and hygiene) by periodic excavations. Frequent movement of the pythons may harden the walls of the burrows. The activity of the porcupines at the burrows is inferred through indirect observations of excavations, tracks, quills, and spoors. The porcupines have not been studied in KNP. The importance of porcupines to the over-winter survival of pythons and incubation of eggs by python in the burrow during summer can not be ignored.

Fluctuating water level in the KNP is an important factor affecting python distribution. Most python burrows are located in elevated areas or away from the wetland (Bhupathy and Vijayan, 1989). However, it is our observation that the flooded area has increased from previous years even when the quantum of water input was low. This could be explained by a decrease in the water holding capacity (depth) of the wetland due to siltation and eutrophication. Regulation of the water input to the wetland and the de-silting undertaken by the Forest Department are not only important to maintain the wetland

for migratory waterfowl, but also to the dry land for terrestrial fauna, including the pythons.

Increased tourism since the last study plays a role in influencing the activity of pythons as indicated by Daniel (1983). Burrows with a higher number of pythons and easy access are highly disturbed by human visitation. Tourist disturbance was the highest during December and January. The local villagers avoid the pythons unless the burrows happen to be near their wood or grass collecting areas. We observed that the mere presence or movement of people or other large animals (cattle) disturb basking pythons and cause their return to the burrows. However, in some cases it does appear that pythons in the high tourism areas are less wary of humans and flee only when a perceived threat approaches too close. Disturbance affects the activity pattern. Growth, reproduction and health may be affected when an individual python is unable to reach its optimal body temperature for a prolonged period; this may have deleterious, even fatal consequences.

The possibility of constructing artificial burrows to aid tourism should be investigated. Fencing has been done for *Gopherus agassizii* (desert tortoise) to restrict the direct movement of these tortoises. Transparent or see through hardware-cloth fences prevent collection of excessive wind-blown sand, and both humans and the enclosed animal can look over the other side and thus avoid surprise encounters which would stress the animal (Spotila et al., 1994). Somewhat similar structure could be tried such that the tourists do not disturb the python movement and habitat and yet the pythons can still move freely. In addition, it is advisable if the python burrows for tourist viewing is restricted to a few which are easily accessed and the remaining left undisturbed. Rotation of tourist-visited burrows through the season will reduce the otherwise sustained levels of disturbance at such sites. Routine monitoring of all burrows could be a good way to monitor distribution and displacement of pythons and their burrows due to disturbance. However, in accordance with the study of Bhatt and Choudhury (1993), we did not observe any signs of pythons moving between burrows till the end of February.

Understanding the biology of a species is critical for effective conservation and management, as was stressed by Gibbons (1986); a detailed study should be conducted on the pythons in KNP, other protected areas, and the adjoining agricultural/rural areas. The python occupies a position high in the trophic structure, thus the problem of biomagnifications and bioaccumulation of pesticides could be prevalent (Shine, 1994) and should be investigated in this population.

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Ramphotyphlops braminus (Daudin): a synopsis of morphology, taxonomy, nomenclature and distribution (Serpentes: Typhlopidae)

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(with three text-figures)

ABSTRACT.– **A brief review is presented for the parthenogenetic blindsnake,** *Ramphotyphlops braminus. Typhlops khoratensis* **is shown to be a synonym. A synopsis of morphological and systematic characters, all synonyms and name variants and global distribution records are provided.**

KEY WORDS.– ***Ramphotyphlops braminus, Typhlops khoratensis,*** **morphology, taxonomy, synonymy, distribution, Thailand.**

Introduction

Robb (1966) separated a group of Australasian blindsnakes in the genus *Typhlops* Oppel (1811) into the genus *Ramphotyphlops* Fitzinger (1843) based on unique features of the male reproductive system, namely the presence of solid, protrusible hemipenes (that coil helically when withdrawn into the tail) and retrocloacal sacs in the posterior coelom (Robb, 1960, 1966). In a revision of the Typhlopidae of New Guinea, inhabited by species belonging to both *Typhlops* and *Ramphotyphlops,* McDowell (1974) substituted the name *Typhlina* for *Ramphotyphlops,* which he believed had priority. The species previously known as *Typhlops braminus* was questionably transferred to *Typhlina* by McDowell (1974) based on similarity to the New Guinean *Ramphotyphlops erycinus* (a member of the *R. polygrammicus* group) in number of longitudinal and transverse scale rows, lateral tongue papillae, form of the rostral shield and superior nasal suture. In referring *braminus* to *Typhlina,* McDowell (1974) stated that "its proper generic assignment cannot be determined with certainty" because males were unknown. Stimpson et al. (1977) contested McDowell's usage of *Typhlina* and the name *Ramphotyphlops* was conserved under Opinion 1207 (Intern. Comm. Zool. Nomen., 1982), thus rendering the valid name to be *Ramphotyphlops braminus.*

No one has offered a better alternative than McDowell's (1974) action for this unusual species so it has remained in *Ramphotyphlops* for more than 30 years. Storr (1981) declared that *R. braminus* "does not certainly belong to *Ramphotyphlops,"* Darevsky et al. (1985) emphasized that generic allocation to *Ramphotyphlops* "is based on uncertain features of the external morphology," O'Shea (1996) emphasized that "its exact generic status is difficult to determine," and Lazell (2002) stated that placement in *Ramphotyphlops* is "rank speculation: there are no relevant diagnostic characters." Furthermore, Lazell (2006) provides additional evidence for not placing *braminus* in *Ramphotyphlops*. In a revision of African Typhlopidae, Roux-Estève (1974) placed the introduced *Typhlops braminus* in her *Typhlops* Groupe I (along with *Typhlops caecatus* and *T. zenkeri),* a move that was criticized by Hahn (1977) and not supported by the phylogenetic analysis of Wallach (1998b). The similarities of *Typhlops caecatus* and *Typhlops zenkeri* tc *Ramphotyphlops braminus* (narrow rostral, divided nasal, nostril adjacent to rostral, 18–2(scale rows and small size) can be attributed t(convergence and/or plesiomorphic conditions

Materials and methods

This synopsis is based upon a review of published literature and data from museum specimens. A more thorough analysis covering all aspects of the biology and natural history of *Ramphotyphlops braminus* is in progress, pending examination of material from all countries. Museum acronyms follow Leviton et al. (1985) with the addition of TNRC = Thailand National Research Center, Bangkok.

Geographical regions in Tables 1–2 include the following areas (complete listing of countries and islands/islets given in Distribution section below): 1) South Asia (including Southwest Asia), 2) Indochina (Southeast Asia excluding Malaysia, 3) East Asia (including the Philippines), 4) Indian Ocean, 5) East Indies (peninsular Malaysia to Solomon Islands and Australia), 6) Pacific Ocean, 7) Africa (including Canary Islands) and 8) New World.

Morphology

Ramphotyphlops braminus is one of the smallest snakes in the world and it is usually the smallest member of the snake fauna wherever it occurs (except India and Sri Lanka). It is so small it is often mistaken for an earthworm. There are a number of misconceptions and considerable erroneous data about *Ramphotyphlops braminus* in the literature and one intent of this paper is to clarify them.

Size and proportion.– Exaggerated claims of the maximum size of *Ramphotyphlops braminus* have been made and repeated in the literature. Unconfirmed reports listing the maximum length as 220–230 mm (Chaudhari, 1986; Cox et al., 1998; Goris and Maeda, 2004; Whitaker and Captain, 2004; O'Shea, 2007) were probably based upon a misidentification by Smedley (1931) of a 230 mm *Ramphotyphlops albiceps* that was reported as a *Typhlops braminus*. Numerous reports of lengths between 170–190 mm indicate that *R. braminus* occasionally reaches such lengths. A few early reports of lengths greater than 190 mm include 197 mm by Cantor (1847), 198 mm by Deraniyagala (1955—repeated by Silva, 1980 and Schleich and Kästle, 2002) and 203 mm by Günther (1864). The most reliable maximum lengths, based upon actual museum specimens, are 197 mm by Wu et al. (1985: Guizhou Mus. no. 7610173—repeated by Lazell, 2002), 200 mm by Bourret (1934: Université de Hanoi no. M.428) and 203 mm by Husain and Tilak (1995: ZSI Northern Regional Station, uncat.). These specimens have not been examined to confirm identification but they are provisionally accepted and indeed represent giants if correct. The largest and smallest specimens I have seen to date measured 178 mm (NHRM 12438) and 55 mm (UPNG 7069). Ota et al. (1991) found juveniles to range in length from 61–119 mm, whereas, sexually mature adults had a range of lengths from 95–179 mm. A sample of 1286 worldwide *Ramphotyphlops braminus* has an average length of less than 130 mm. Total length varies from 43–203

Table 1. Total length, proportion and body weight data for *Ramphotyphlops braminus* by region (1 = South Asia, 2 = Indochina, 3 = East Asia, 4 = Indian Ocean, 5 = East Indies, 6 = Pacific Ocean, 7 = Africa, 8 = New World, x = mean, n = sample size, X = grand mean)

Region	Total length (mm)			Length/width ratio			Juvenile body weight (gm)			Adult body weight (gm)		
	x	Range	*n*	*x*	Range	*n*	*x*	Range	*n*	*x*	Range	*n*
1	126.4	63 – 203	54	55.8	55.8	1	–	–	–	0.72	0.30 – 1.00	21
2	117.5	57 – 200	240	42.8	30.1 – 57.4	214	0.26	0.05 – 0.6	41	0.77	0.30 – 1.87	131
3	132.5	60 – 197	725	41.5	31.8 – 60.3	243	0.17	0.1 – 0.4	15	0.76	0.30 – 1.40	40
4	124.0	66 – 178	66	40.6	32.9 – 59.5	62	–	–	–	0.80	0.80	1
5	128.9	61 – 173	102	–	–	–	0.12	0.12	1	–	–	–
6	127.7	68 – 153	44	49.4	34.1 – 54.7	25	0.2	0.1 – 0.4	10	0.70	0.30 – 1.40	89
7	120.4	43 – 161	43	56.0	56.0	1	–	–	–	–	–	–
8	102.1	68 – 164	12	37.7	37.7	1	0.15	0.1 – 0.2	2	0.70	0.50 – 0.90	6
X	**127.9**	**43 – 203**	**1286**	**41.9**	**30.1 – 60.3**	**547**	**0.23**	**0.05 – 0.6**	**69**	**0.74**	**0.30 – 1.87**	**288**

Table 2. Total middorsals, caudals and vertebral data for *Ramphotyphlops braminus* by region. See Table 1 for key to regions.

Region	Total middorsals			Caudal scales			Total vertebrae			Costal/vertebral ratio		
	x	Range	*n*	*x*	Range	*n*	*x*	Range	*n*	*x*	Range	*n*
1	311.4	281 – 368	49	12.0	11 – 13	2	192.2	187 – 206	5	1.64	1.59 – 1.69	5
2	320.3	261 – 344	226	12.0	12	1	–	–	–	–	–	–
3	318.0	261 – 341	140	12.7	11 – 15	255	186.7	175 – 192	252	1.70	1.65 – 1.78	252
4	318.4	296 – 336	100	11.0	8 – 13	64	184.5	182 – 195	35	1.74	1.39 – 1.82	32
5	329.8	297 – 353	27	–	–	–	–	–	–	–	–	–
6	318.8	295 – 338	39	12.5	12 – 13	25	187.8	183 – 192	23	1.68	–	23
7	324.1	306 – 360	38	10.0	10	1	185.7	179 – 196	23	1.75	1.65 – 1.87	23
8	316.1	290 – 337	75	10.3	10 - 11	4	179.8	178 – 182	4	–	–	–
X	**319.0**	**261 – 368**	**694**	**12.4**	**8 – 15**	**352**	**186.5**	**175 – 206**	**342**	**1.71**	**1.39 – 1.87**	**335**

mm (x = 127.9, n = 1286) in *R. braminus* (Table 1). Midbody diameter ranges from 1.4–4.2 mm (x = 2.7, n = 214) and relative body thickness (= total length/midbody diameter ratio) varies from 30–57 (x = 43, n = 215) in Thai specimens (Niyomwan, 1999).

There are few published records on body weights of live or freshly killed *Ramphotyphlops braminus* but available data indicate that it is not only one of the shortest snakes known but it is also one of the lightest (essentially the smallest snake known worldwide). A Sarawak neonate, 61 mm in length, weighed 0.12 gm (Das and Charles, 1993). A 123 mm Florida specimen weighed 0.7 gm (Grace and Van Dyke, 2004) and a 142 mm specimen from Madagascar weighed 0.8 gm (Mori et al., 2006). Records of body weights taken in the field from USNM and CAS specimens reveal that neonates weigh only 0.1 gm. The lightest and heaviest recorded specimens of *Ramphotyphlops braminus* come from Thailand (Niyomwan, 1999): CUB 2000.9 weighed 0.05 gm and CUB 2000.207 weighed 1.87 gm. If these two outliers are excluded the

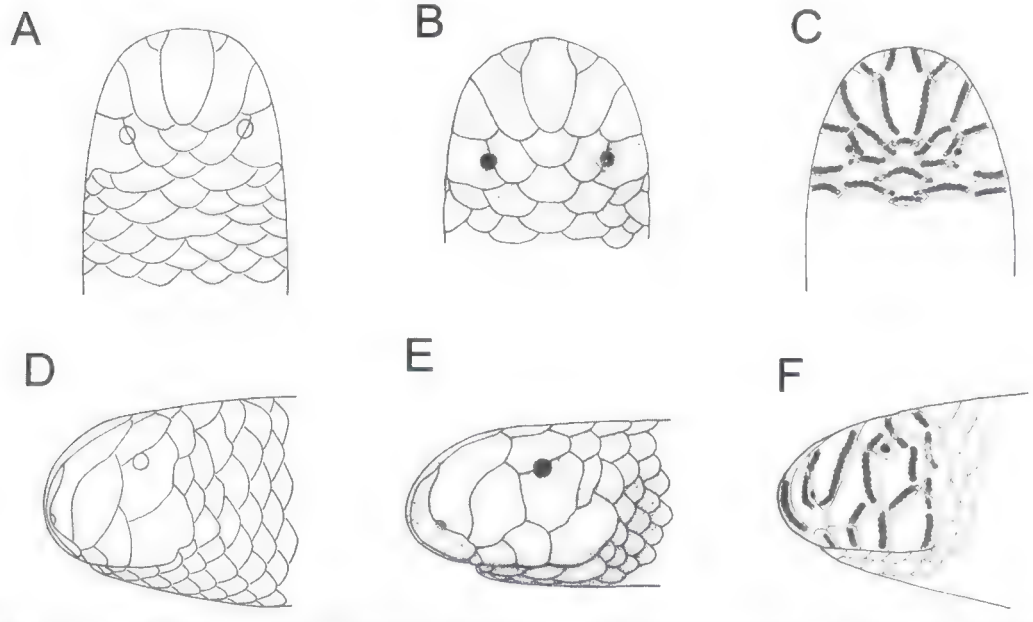

Figure 1A–C. Dorsal view of head of *Ramphotyphlops braminus* (after Roux-Estève, 1974, Gasperetti, 1988 and Smith, 1943, respectively). **D–F.** Lateral view of head of *Ramphotyphlops braminus* (after Roux-Estève, 1974, Gasperetti, 1988 and Smith, 1943, respectively).

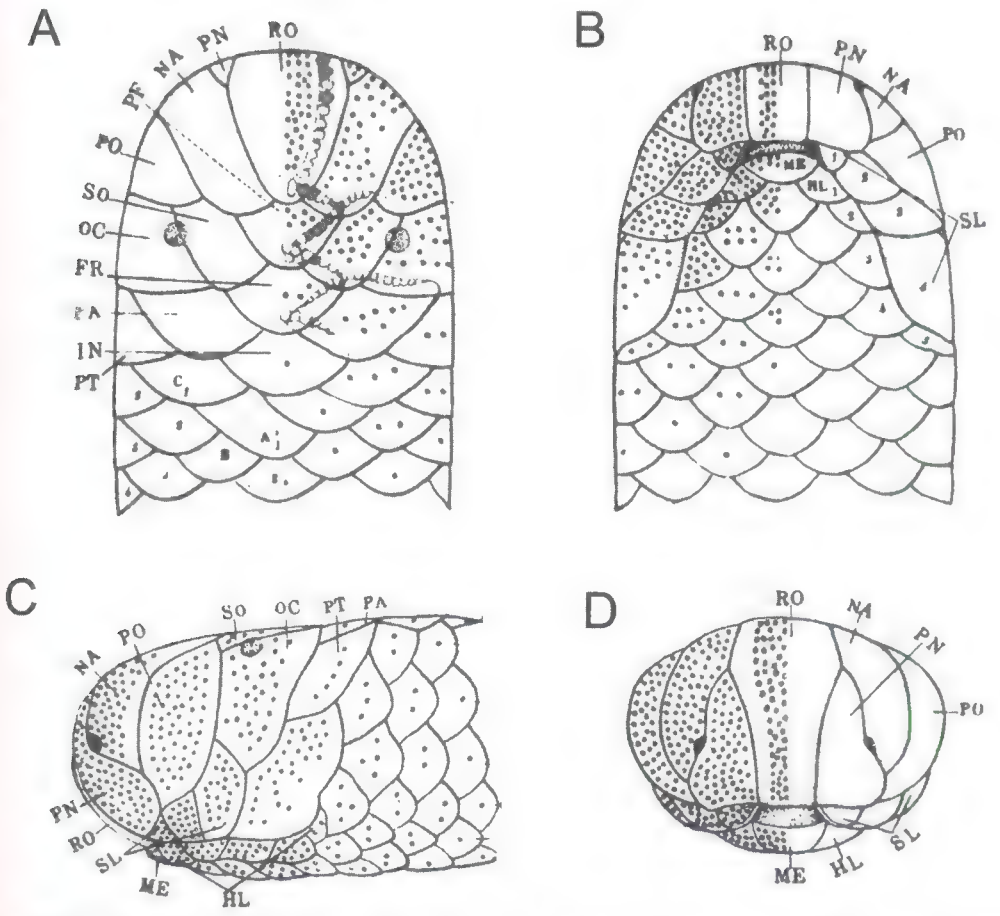

Figure 2A–D. Integumentary sense organs of *Ramphotyphlops braminus* (after Aota, 1940). A = dorsal view, B = ventral view, C = lateral view, D = frontal view. Current terminology for head shields: FR = postfrontal, HL = infralabial, IN = interparietal, ME = mental, NA = supra- or posterior nasal, OC = ocular, PA = parietal, PF = frontal, PN = infra- or anterior nasal, PO = preocular, PT = postocular, RO = rostral, SL = supralabial, SO = supraocular.

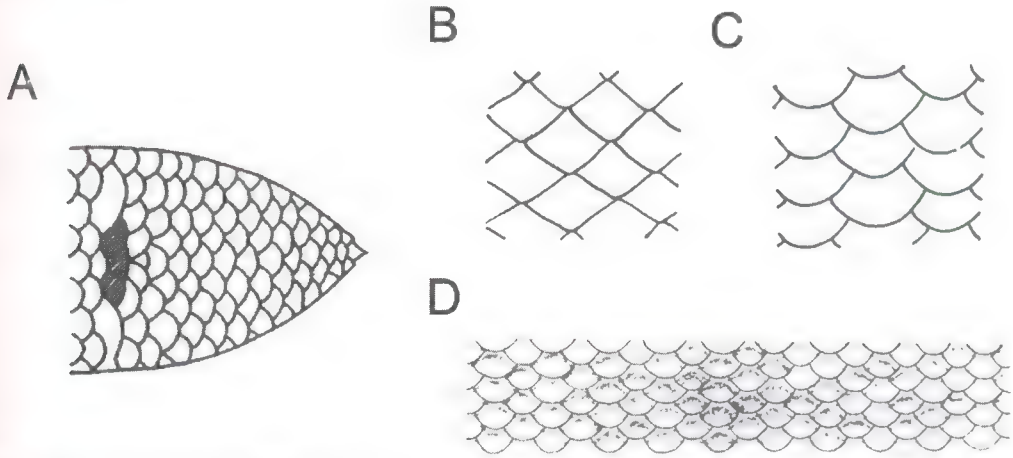

Figure 3A. Ventral view of tail of *Ramphotyphlops braminus* (after Niyomwan, 1999). **B–C.** Ventral scale pattern of *Ramphotyphlops braminus* compared with typical members of *Ramphotyphlops* (after Storr, 1981). **3D.** General scale pattern of *Ramphotyphlops braminus* (after Gasperetti, 1988).

mean body weight for 355 live or freshly killed specimens (CAS and USNM field records; Niyomwan, 1999) is 0.64 gm (range = 0.5–1.4) with juveniles having a mean weight of 0.23 gm (range = 0.1–0.6, $n = 68$) and adults a mean weight of 0.74 gm (range = 0.3–1.4, $n = 287$) (Table 1).

Scalation.– There are invariably 20 scale rows throughout the body (i.e., 20–20–20 in traditional scolecophidian counting methods) in *Ramphotyphlops braminus*, notwithstanding reports of 18–20 rows by Easa and Ramachandran (2004), 18–21 rows by Minton (1966), Mertens (1969) and Khan (1982, 1999), 18–25 rows by Sarker (1990) and 16–36 rows by Nanhoe and Ouboter (1987). It is possible that an aberrant specimen may have an extra row or less (as some snakes occasionally display) but the majority of the above citations must be based upon misidentifications or perpetuation of errors from the literature.

There are 261–368 ($x = 319.0$, $n = 694$) total middorsal scales between the rostral and terminal spine in *Ramphotyphlops braminus* (Table 2). The majority of specimens vary from 290–350 when discounting six outliers with 261, 281, 283, 360, 361 and 368 middorsal counts. The lowest middorsal count of 261 comes from a Thailand specimen (Niyomwan, 1999) and a Ryukyu, Japan snake (Ota, 1985) and the highest count of 368 from an Indian snake (Roux-Estève, 1974). The lowest mean count comes from a series of 14 Pakistani snakes ($x = 294$; Akram and Qureshi, 1995) while the highest mean count comes from a series of six Bougainville snakes ($x = 343$; Wallach, unpubl.).

The tail is very short in *Ramphotyphlops braminus* with a mean of 12.4 caudal scales (range 8–15, $n = 352$) (Ota et al., 1993; Wallach, unpubl.) (Table 2). The mean relative tail length is 2.4% (range = 1.4–3.0%, $n = 213$) in Thailand and 2.5% (range = 2.0–3.0%, $n = 53$) in Madagascar; it is slightly longer than broad with a length/width ratio of 1.2 (range = 0.7–1.7, $n = 213$) in Thailand and 1.5 (range = 1.2–2.0, $n = 53$) in Madagascar (Niyomwan, 1999; Wallach, unpubl.) (Table 3).

Vertebrae.– The total number of vertebrae (including axis, atlas, trunk, cloacal and caudal) ranges from 175–206 (x = 186.5, n = 342) in *Ramphotyphlops braminus* (Table 2). Vertebral number is highest in South Asia (x = 192.2) and lowest in the Indian Ocean (x = 184.5). If seven outliers of 175, 178, 179, 179, 193, 195 and 206 are excluded the range is narrowed to 180–192. The vertebral range of 180–192 is thus nearly three times less variable than the middorsal range of 290–350 (6.3% vs. 17.1%), suggesting that examination of vertebral counts may be useful as a taxonomic character in *Ramphotyphlops braminus*.

When the total middorsal scale count (or middorsal costals) is divided by the total number of vertebrae, the result is a costal/vertebral (or C/V) ratio. The C/V ratio in *Ramphotyphlops braminus* varies from 1.39–1.87 ($x = 1.71$, $n = 335$) with the lowest value coming from the Indian Ocean (1.39) and the highest from Africa (1.87) (Table 2). The lowest regional mean value is found in South Asia (1.64) and the highest in Africa (1.75)

Table 3. Comparisons of juvenile and adult characters in Thailand *Ramphotyphlops braminus* (from Niyomwan, 1999). Data presented as mean (range) sample size.

Character	All	Adults	Juveniles
Total middorsals	326.9 (261-352) 208	326.8 (261-352) 151	327.2 (291-345) 57
LOA (mm)	116.9 (61-168) 215	128.5 (90-168) 155	86.8 (61-107) 60
Tail length (mm)	2.61 (1.34-4.42) 213	2.84 (1.9-4.42) 154	2.00 (1.34-2.84) 59
Relative tail length (%)	2.36 (1.38-2.76) 213	2.37 (1.38-2.76) 154	2.34 (1.79-2.96) 59
Midbody diameter (mm)	2.74 (1.42-4.16) 215	3.00 (2.04-4.16) 155	2.08 (1.42-2.76) 60
Lenth/width ratio	42.8 (30.1-57.4) 213	43.1 (32.6-57.4) 155	42.0 (30.1-53.6) 60
Midtail diameter (mm)	2.24 (1.14-3.48) 214	2.45 (1.78-3.48) 154	1.70 (1.14-2.20) 60
Tail length/width ratio	1.17 (0.72-1.68) 213	1.17 (0.72-1.59) 154	1.18 (0.83-1.68) 59
Body weight (gm)	0.64 (0.05-1.87) 160	0.76 (0.32-1.87) 122	0.26 (0.05-0.60) 38

Description.– Snout rounded in dorsal and lateral views; rostral oval and narrow (0.25–0.33 interocular head width), not reaching eye level, with anterior constriction visible dorsally; supraocular oblique, twice as long as broad; frontal, postfrontal and interparietal smaller than supraocular, occasionally transversely enlarged; parietals transverse, enlarged and occipitals occasionally enlarged (Fig. 1A). Nostrils lateral, small and circular with a nearly horizontal and transverse nasal canal; nasal completely divided, posterior border strongly concave, inferior nasal suture contacting preocular and superior nasal suture extending onto dorsum of snout to contact rostral at point of constriction (Fig. 1A–B); preocular and ocular subequal in size; eye small, usually with distinct pupil, located near or partially under the lateral border of the supraocular; a single postocular, twice the height of the costal scales, possibly the result of fusion of two small postoculars; supralabial imbrication pattern T–III, fourth supralabial larger than other three supralabials combined and subequal to ocular, with a posterior notch suggesting the fusion of another scale with the supralabial (Fig. 1D–E).

Anterior head shields usually have distinct rows of whitish glands beneath their posterior borders, with the prenasal gland line confluent with the posterior rostral gland line dorsally (to the exclusion of the anterior rostral gland line) (Fig. 1C). The glands have been described as forming "a faint crenellated whitish marginal line" (Murray, 1884).

Additionally, head shields are covered with numerous tiny integumentary sense organs, concentrated most heavily on the anterior surfaces of the head. Counts of integumental organs on head shields from a single Ryukyu Island *Ramphotyphlops braminus* demonstrates this fact: of the 1106 cephalic sense organs, 636 occur on anterior shields, 276 on ventral shields and lower half of lateral shields and 194 on the dorsal shields and upper half of lateral shields (Aota, 1940). Distribution on shields is as follows: superior nasal (172), inferior nasal (152), rostral (142), supralabials I–III (140), supralabial IV (94), infralabials (54), supraocular (30), frontal (10), postfrontal (10), parietal (14), interparietal (2), ocular (58), postocular (10) (Aota, 1940:Fig. 2).

Costal scales imbricate and often cycloid at least dorsally (Fig. 3C–D); ventrally the scales appear more trapezoidal in shape with nearly point contact (Storr, 1981:Fig. 3B). Tail slightly longer than broad (Fig. 3A); apical spine with stout base, directed horizontally; tongue with a pair of lateral papillae near base of bifurcation.

Colouration.– The scales are smooth and highly polished and colouration varies from light brown to black dorsally, somewhat lighter ventrally. In lighter coloured specimens there is a dark, triangular apical spot covering the anterior 1/4–1/2 of each scale. Wall (1923b) records it as the basal 2/5 of the scale. The lower snout, chin, cloacal region and tail tip are usually pale cream or white in colour. In arid and sandy regions it is uniformly pink, beige, or reddish-brown in colour (Gasperetti, 1977, 1988; Gallagher, 1990; Jongbloed, 2000; Khan, 2002). The tongue is white in colour (Cantor, 1847).

Typhlops khoratensis

Ramphotyphlops braminus (Daudin, 1803) appears to be more closely related to the *Typhlops pammeces* species group from India and Sri Lanka than to the *Ramphotyphlops polygrammicus* group as suggested by McDowell (1974) (Wallach, 1998b). The *Typhlops pammeces* group occupies the same geographical region in which *Ramphotyphlops braminus* is likely to have evolved. It is very difficult, if not impossible, to distinguish several of the species from *R. braminus*. Lateral tongue papillae are present in the only member of the group thus far examined *(T. pammeces)* (Wallach, 1998b). Previous reports of male *Typhlops braminus* (Wall, 1909, 1921; List, 1958; Silva, 1980) are probably misidentifications of similar looking species from the *T. pammeces* group (Nussbaum, 1980; Greer, 1997). The *T. pammeces* group currently includes *Typhlops jerdoni, T. lankaensis, T. leucomelas, T. malcolmi, T. pammeces, T. tenebrarum, T. veddae and T. violaceus*. This group is characterized by 20 scale rows, a T–III supralabial imbrication pattern, a completely divided nasal with superior suture visible dorsally and a narrow rostral. Additionally, all species have subcaudal counts, body lengths, relative tail lengths and length/width ratios similar to those of *R. braminus*. Some members also have

a preocular contact with the nasal suture and a single postocular (Table 4).

It is nearly impossible to distinguish the Thailand species *Typhlops khoratensis* Taylor, 1962 from *Ramphotyphlops braminus*. *Typhlops khoratensis* was distinguished by Taylor (1962, 1965) from *R. braminus* by the following characters: 1) enlarged occipitals vs. occipitals not enlarged, 2) faint eyespot vs. distinct eye with pupil, 3) middorsals 315–326 vs. 290–310, 4) maximum length 130 mm vs. 180 mm, 5) first three vertebral head scales enlarged vs. not enlarged, 6) length/width ratio 28–43 vs. 30–45 and 7) cephalic glands not distinct vs. distinct. Niyomwan et al. (2001) used the following three characters in their key to separate *R. braminus* from *T. khoratensis:* 1) distinct cephalic gland lines, 2) visible pupil and 3) interorbital diameter/snout-vent length ratio. However, a comparison of the following *R. khoratensis* mean and range statistical values with those of *T. braminus* reveals that *T. khoratensis* falls within the range of *R. braminus* for every character (data presented for *T. khoratensis* first, *R. braminus* second): total length (91–153 mm, x = 117 mm vs. 43–203 mm, x = 128 mm), total middorsals (315–328, x = 323 vs. 261–368, x = 319), length/width ratio (28–58, x = 42 vs. 30–60, x = 42), subcaudals (10–12, x = 11.3, vs. 8–15, x = 12.4), tail length/width ratio (1.4–2.5, x = 2.0 vs. 0.7–3.0, x = 1.2) and rostral width (0.27 0.38, x = 0.29 vs. 0.25–0.33, x = 0.31).

The presence of enlarged occipitals (= second parietals of Taylor) is not restricted to *Typhlops khoratensis*. The occipitals may be as broad as the parietals or somewhat narrower (in a paratype, MCZ 74097, the parietals are 2.5 costals wide and the occipitals are 2.0 costals wide). Likewise, many *Ramphotyphlops braminus* have partially or completely enlarged occipitals (Wallach, pers. obs.). Concerning the eyespot of *T. khoratensis,* an eye with a distinct pupil is present in at least one specimen (MCZ 181197) and occasionally only an eyespot is present in *R. braminus* (Wallach, pers. obs.). The known range of middorsals in *R. braminus* is 258–368 so presumably Taylor's data was for Thai specimens. Niyomwan (1999) reported a range of 258–344 middorsals for *R. braminus* in Thailand, which encompasses the range for *T. khoratensis*. Regarding total length, Niyomwan (1999) reported the lengths of 214 Thai specimens of *R. braminus* as 61–168 mm (x = 116.9, n = 215) so the range of 91 153 mm (x = 116.0, n = 11) in *T. khoratensis* is within that for *R. braminus* and the mean values are nearly identical in Thailand. Likewise, the first three vertebrals (frontal, postfrontal and interparietal) are occasionally transversely enlarged in *Ramphotyphlops braminus*. The length/width ratio

Table 4. Data on known specimens of *Typhlops khoratensis*. T = type status (H = holotype, P = paratype, T = topotype, N = nontype), S = sex (F = female), L = total length, L/W = total length/midbody diameter, T = tail length, T/L = tail length/total length, MD = middorsals, SC = subcaudals, R = rostral width/head width, PO = postoculars, O = occipitals enlarged, E = eye (+ = eyespot, 0 = pupil present), EP = eye beneath supraocular and ocular, V = vertebrals enlarged, * Niyomwan (1999) counted 329 total middorsals and I counted 331.

Mus. No.	Former No.	T	S	L	L/W	T	T/L	MD	SC	R	PO	O	E	P	V
FMNH 178263	EHT 3182	H	?	128.0	41.5	3.0	2.34	315	?	0.27	1	+	+	+	3
FMNH 178264	EHT 267	P	?	105.0	37.0	2.0	1.90	320	?	0.29	1	+	?	+	3
FMNH 178265	EHT 268	P	?	107.0	43.7	2.0	1.87	326	?	0.28	1	+	?	+	3
FMNH 178266	EHT 33325	P/T	F	102.0	33.0	2.0	1.96	330*	?	0.26	1	+	?	+	3
MCZ 74097	EHT 612	P	F	106.0	40.0	2.0	1.89	319	12	0.28	1	+	+	+	3
NMW 291	—	P	?	121.0	33.0	2.3	1.90	321	?	0.24	1	+	?	+	3
NMW 292	—	P	?	121.0	28.0	3.0	2.48	319	?	0.25	1	+	?	+	3
FMNH 189933	EHT 33330	T	F	91.0	46.8	2.5	1.43	325	11	0.29	1	+	+	+	3
MCZ 181197	NTRC uncat.	N	F	138.0	56.6	3.5	2.47	328	12	0.33	1	+	0	+	3
CAS 13667	—	N	F	153.0	57.8	3.0	1.92	324	10	0.38	1	+	+	+	3
Mean	—	—	—	117.2	41.7	2.5	2.02	322.7	11.3	0.29	1	—	—	—	3

of *T. khoratensis,* which is 28–58 with additonal specimens, also falls within the range of *R. braminus* (30–65). Taylor (1962, 1965) and Niyomwan et al. (2001) claimed that the cephalic gland pattern is different in *T. khoratensis* than that of *R. braminus,* but I find the gland pattern to be identical to that of *R. braminus* and the cephalic glands occasionally are not distinctly visible in *R. braminus.* Niyomwan (1999) and Niyomwan et al. (2001) found the interorbital diameter/snout-vent length ratio in *T. khoratensis* to be 0.0142 ($n = 1$) and 0.0052–0.0105 in *R. braminus* ($n = 206$) but the sample of *T. khoratensis* was only one specimen. A larger sample size would undoubtedly increase the range of values for *T. khoratensis* (possibly resulting in an overlap of values for that character).

In addition to all scale counts, proportions and measurements of *Typhlops khoratensis* falling within the range of *Ramphotyphlops braminus* (Table 5), *T. khoratensis* exhibits the greatly enlarged fourth supralabial with posterior notch of *R. braminus* and all specimens identified by gender are females. Examination of the viscera of two specimens (FMNH 189933, topotype; MCZ 181197) reveals no significant differences from the viscera of *R. braminus* (Wallach, pers. obs.). In view of the above data, I find no compelling evidence to support the recognition of *Typhlops khoratensis* as a valid species and it is thereby referred to the synonymy of *Ramphotyphlops braminus.*

Two other species that closely resemble *Ramphotyphlops braminus* are *Typhlops lankaensis* and *T. violaceus* from Sri Lanka. These two species both possess the key diagnostic characters of *R. braminus:* completely divided nasal shield with inferior suture contacting the preocular and superior suture extending onto dorsum of snout. Additionally, they have 20 scale rows, a narrow rostral shield (< 1/3 head width), one postocular, small size (maximum length less than 145 mm) and a moderate length/width ratio (27–43). The total middorsal counts for *Typhlops lankaensis* (229–261) and *T. violaceus* (245–269) fall below the minimum for *R. braminus.* The middorsal count minima of *Ramphotyphlops braminus* are outliers of 261 (Japan and Thailand), 281 (Pakistan) and 283 (India) but the vast majority of specimens have more than 290 middorsals (Table 5). Middorsal scale count thus appears to be a character separating *T. lankaensis* and *T. violaceus* from *R. braminus.*

Species that have a completely divided nasal that extends onto the dorsum of the snout, a narrow rostral and 20 scale rows include *Typhlops jerdoni, T. leucomelas, T. malcolmi, T. pammeces, T. tenebrarum, T. veddae* (all from the *T. pammeces* group) plus *Ramphotyphlops erycinus* from Indonesia. However, they all have the nasal suture contacting a supralabial shield and some have two postoculars while others are much larger in size. Two Australian species, *Austrotyphlops micromma* and *A. troglodytes,* also have the completely divided nasal with suture visible dorsally but the rostral is broad, scale rows are 18 and 22, respectively and the middorsal counts are greater than 490. Another group of Australian species, *Austrotyphlops endoterus, A. pilbarensis and A. yampiensis,* has the nasal suture contacting the preocular but the nasal is not divided, the superior suture not visible dorsally, the rostral is broad, the scale rows are 18 or 22, the middorsal count is high, multiple postoculars are present and the body size is large. Lastly, another group of Australian species, *Austrotyphlops ammodytes, A. diversus and A. tovelli,* has the nasal suture contacting the preocular, a narrow rostral and 20 scale rows but the superior suture not visible dorsally: in *A. ammodytes* and *A. diversus* a single postocular is present but middorsal counts are greater than 400 and the size is large, in *A. tovelli* the nasal is completely divided and there are two postoculars (Table 5).

Taxonomy

McDowell (1974) was the first to suggest that *Ramphotyphlops braminus* was an all-female species based upon a sample of 114 mostly Asian and Indonesian specimens, none of which was male. Similar results were found by Nussbaum (1980) in 32 Seychelles specimens, Ota et al. (1991) in 276 specimens mainly from Japan and Taiwan, Vyas (1993) in six Indian specimens and Greer (1997) in 14 New Caledonia specimens. The only reports of "male" *Ramphotyphlops braminus* (Wall, 1918, 1921, one from Assam, India; List, 1958, two from Sri Lanka) most likely stem from misidentifications of *braminus*-like members of the *Typhlops pammeces* group. McDowell (1967) even pointed

Table 5. Comparison of *Ramphotyphlops braminus* with all Australasian typhlopids (A = *Austrotyphlops*, R = *Ramphotyphlops* and T = *Typhlops*) having a T-III SIP and at least the inferior nasal suture in contact with preocular, completely divided nasal, or superior nasal suture visible dorsally. MSR = midbody scale rows, TMD = total middorsals, SC = subcaudals, INS = ventral contact of inferior nasal suture, ND = division of nasal (+ = complete, 0 = incomplete), SNS = superior nasal suture extending onto dorsum of snout, RW = rostral width (N = narrow, M = moderate, B = broad), LOA = total length, PO = number of postoculars, L/W = total length/midbody diameter ratio, LTP = lateral tongue papillae, RTL = tail length as percent total length.

Species	MSR	TMD	SC	INS	ND	SNS	RW	LOA	PO	L/W	LTP	RTL
R. braminus	20	261-368	8-15	PO	+	+	N	43-203	1	30-60	+	1.4-3.0
T. khoratensis	20	315-328	10-12	PO	+	+	N	91-153	1	28-58	?	1.4-2.5
T. lankaensis	20	229-261	11-15	PO	+	+	N	67-130	1	27-35	?	4.4
T. violaceus	20	245-269	10-13	PO	+	+	N	65-135	1	30-43	?	2.3-3.1
T. jerdoni	20-22	260-313	9-15	SL 2	+	+	N	130-280	2	35-47	?	2.1
T. leucomelas	22	234-235	12-13	SL 2	+	+	N	128-130	2	23-32	?	4.3
T. malcolmi	20	261-282	9-11	SL 2	+	+	N	81-107	1	31-32	?	2.5-4.2
T. pammeces	20	328-400	12-13	SL 2	+	+	N	119-195	1/2	54-75	+	1.9-3.1
T. tenebrarum	20	300-339	11-14	SL 2	+	+	N	65-144	1	43-72	?	2.1-3.0
T. veddae	20	295-309	14	SL 2	+	+	N	93	1	60	?	3.0
R. erycinus	20	315-335	16-23	SL 1	+	+	N	230-297	2	29-31	+	4.5-7.7
R. polygrammicus	22	346-479	10-19	SL 1/2	0	+	B	103-480	2/3	31-60	+	2.3-4.4
R. albiceps	20	301-424	8-25	SL 2	0	+	M	117-302	1/4	51-104	?	1.3-6.7
R. ozakiae	20	291-327	7-12	SL 2	0	+	M	154-176	1	38-53	+	1.8-2.9
A. micromma	18	493	15	SL 2	+	+	B	205	3	?	?	?
A. tovelli	20	263-265	10-12	PO/2	+	0	N	71-122	2	30-47	?	2.6-3.6
A. ligatus	24	314-446	11-17	SL 1	0	+	N	111-485	2/3	20-40	+	2.7-3.9
A. silvia	20	286-334	14-21	SL 2	0	+	B	72-175	3	34	?	2.0-5.3
A. proximus	20	321-360	10-17	SL 1	0	+	B	194-700	2/3	20-40	+	1.4-4.0
A. wiedii	20	381-439	15-17	SL 2	0	+	B	153-315	2	30-80	?	3.0
A. nigrescens	22	396-407	11-20	SL 1/2	0	+	B	103-750	2	30-80	+	2.0-6.4
A. ammodytes	20	407-506	8-18	PO	0	0	N	230-352	1	?	?	?
A. diversus	20	403-465	8-18	PO	0	0	N	97-352	1	40-70	?	1.6-5.1
A. endoterus	22	422-447	9-16	PO	0	0	B	109-376	2/3	40-60	?	1.3-2.9
A. pilbarensis	22	389-440	15-22	PO	0	0	B	118-370	1/2	36-58	?	2.4-4.0
A. yampiensis	18	480	11	PO	0	0	B	128	2	?	?	?
A. troglodytes	22	655	14	SL 2	+	+	B	402	?	?	?	?

out that "a number of different species" have been confused under the name of *"Typhlops braminus."* Wynn et al. (1987) and Ota et al. (1991) demonstrated that *R. braminus* is a triploid parthenogenetic species; being an all-female obligate parthenogen is unique among snakes.

Parthenogenesis has been reported in a few other snakes. Burgin et al. (2000) reported incorrectly that Lawson and Lieb (1990) found *Elaphe* (= *Pantherophis) bairdi* to be parthenogenetic when the latter actually found *P. bairdi* to have hybridized with *P. obsoletus* along a narrow contact zone. Another erroneous report of "parthenogenesis" involves intersexuality in the isolated Queimada Grande Island *Bothrops insularis* with the development of hemipenes in females and a concomitant reduction in number of males over time (Hoge et al., 1960, 1961). Among a sample of 24 wild caught Tennessee *Agkistrodon piscivorus*, 23 were diploid but one individual was a spontaneously produced

triploid that lacked both gonads and hemipenes (Tiersch and Figiel, 1991). Facultative parthenogenesis, which occurs at times in bisexual species, is known in a number of snakes, such as *Python molurus* (Groot et al., 2003), *Acrochordus arafurae* (Dubach et al., 1997), *Nerodia sipedon* (Scalka and Vozenilek, 1986), *Thamnophis elegans, T. marcianus, Crotalus horridus and C. unicolor* (Schuett et al., 1997). However, *Ramphotyphlops braminus* has the distinction of being the only unisexual snake out of some 3,000 known species (Zug et al., 2001; Pough et al., 2004).

The unusual position of *Ramphotyphlops braminus* among scolecophidians is further indicated by the following characters, which are rare among typhlopids: 1) paired parietals (Haas, 1930; Mookerjee and Das, 1932; Mahendra, 1936), 2) weak neural ridge on the axis (List, 1958), 3) lack of participation of the basioccipital in the occipital condyle, a condition also known only in *R. flaviventer* (List, 1966; Greer, 1997), 4) single median ventral foramina in vertebrae (Mahendra, 1935, 1936; List, 1966), 5) marrow spaces lacking within walls of vertebra except for a synapophysial marrow space (Sood, 1948), 6) disposition of the cutaneous glands beneath the head shields, which are confined to the sutures between the shields along the anterior borders of each scale (Taylor, 1962; McDowell, 1974), 7) cephalic sense organs with sunk-in papillae in epidermis (Landmann, 1976), 8) confluence of prenasal gland line with the caudal portion of the rostral line on top of the head, rather than with the cranial portion of the rostral line (McDowell, 1974), 9) dorsal rostral less than 1/3 head width (Günther, 1864; Rooij, 1917; Sharma, 1998), 10) extension of superior nasal suture dorsally and posteriorly on to dorsum of snout to contact rostral—as in some members of the *T. pammeces* species group and *R. erycinus* (McDowell, 1974), 11) inferior nasal suture in contact with preocular rather than a supralabial and containing a small gland—not a striated pit (McDowell, 1974), 12) external nostril with a nearly circular shape with horizontal and transverse nasal passage, other Typhlopidae (except *Typhlops ater* species group) having the nostril elongated and nasal passage oblique (McDowell, 1974; Wallach, pers. obs.), 13) tongue with pair of long, pointed lateral tongue papillae (McDowell, 1974), 14) small gland in the sulcus immediately behind the eye and above the temporalis anterior muscle (Fraser, 1937), 15) multicameral tracheal lung with saccular air cells (Wallach, 1998a), 16) unicameral right lung (Wallach, 1998a) and 17) large pedunculate rectal caecum (McDowell, 1974). Tables 6–7 provide data for comparisons of external and internal characters with all other typhlopid genera.

Characters of *Ramphotyphlops braminus* that are unique among scolecophidians include the following: 1) point contact of the diamond-shaped ventral scales with their neighbors, each of which has a black apical spot (Storr, 1981), 2) fourth supralabial larger than size of other three supralabials combined and presenting a caudal notch, indicating presumed fusion of fourth supralabial with adjacent scale(s)—at least a postocular and possibly surrounding scales (Wallach, pers. obs.) and 3) prenasal-posterior rostral gland lines continuously separated from anterior rostral gland line (McDowell, 1974). The character of *Ramphotyphlops braminus* that is unique among snakes is its unisexual obligate parthenogenetic reproduction (Wynn et al., 1987).

Nomenclature

Listed below are all current and previous synonyms of *Ramphotyphlops braminus,* including the first usage of all name variants, whether emendations, incorrect subsequent spellings, or typographical errors.

Ramphotyphlops braminus (Daudin, 1803)
Flowerpot Snake or Brahminy Blindsnake
"Serpent d'oreille," Lacepède, 1789:458.
"Rondoo Talooloo Pam," Russell, 1796:48, pl. 43. Type specimen: lost. Type locality: "Vizagapatnam, coast of Coromandel, India" [= Visakhapatnam, N Andhra Pradesh, SE India].
"Punctulated slow-worm," Shaw, 1802:589.
Eryx braminus Daudin, 1803:279. Iconotype [holotype fide Smith and Taylor, 1945:19; lectotype fide Kramer, 1977:758]:pl. 43 in Russell, 1796:48. Type locality: "Bengale, India."
"Typhlops rondoo-talaloo," Cuvier, 1816:63.
Tortrix Russelii Merrem, 1820:84. Iconotype:pl. 43 in Russell, 1796. Type

locality: "India orientali" [= eastern India]. Synonymy fide Schinz, 1834 in 1833–1835: 130.

Erix Braminus, Bory de Saint-Vincent, 1824:271. [unjustified emendation]

Eryx russelii, Wagler, 1825–1833:5. [nomen ineditum]

Typhlops Braminus, Fitzinger, 1826:53.

Typhlops braminus, Cuvier, 1828:103.

"Rondos-talaloopam," Cuvier, 1831:56.

"Rondos Tolaloopam," Cuvier, 1832:100.

Typhlops bramineus, Schinz, 1834 in 1833–1835:130. [unjustified emendation]

Typhlops Russeli, Schlegel, 1839 in 1837–1844:39. [unjustified emendation]

Tortrix braminus, Schlegel, 1839 in 1837–1844:39.

Argyrophis Bramicus, Gray, 1845:138. [unjustified emendation]. Synonymy fide Beddome, 1867:16.

Argyrophis truncatus Gray, 1845:138. Syntypes (3): BMNH 1946.1.11.9–11. Type locality: "Philippines." Synonymy fide Peters, 1865:262.

Eryx bramicus, Gray, 1845:138. [unjustified emendation]

Tortrix Bramicus, Gray, 1845:279. [unjustified emendation]

Onychocephalus Capensis Smith, 1838/46 *in* 1838–1849:111 (unnumbered), pl. 51, fig. 3, pl. 54, figs. 9–16. Syntypes (3): BMNH 1865.5.4.74–76. Type locality: "interior of Southern Africa" [= Cape of Good Hope, South Africa]. Synonymy fide Peters, 1865:263. [Waterhouse (1880), Barnard (1950) and Ulber (1999) cite the date as December 1846 for part 24 while Branch and Bauer (2005) list the date as 1838].

Typhlops brame, Duméril, 1853:423. [unjustified emendation]

Typhlops Russellii, Jerdon, 1853:527. [unjustified emendation]

Typhlops capensis, Peters, 1854:621.

Argyrophis Braminus, Blyth, 1856:712.

Argyrophis bramicus, Tennent, 1859:203.

Onychocephalus capensis, Peters, 1860:83.

Ophthalmidium tenue Hallowell, 1861:497. Syntypes (3): presumably ANSP, either missing or lost. Type locality: "Hong-Kong, China." Synonymy fide Boettger, 1888: 70.

Typhlops (Typhlops) braminus, Jan, 1863:11.

Typhlops (Typhlops) inconspicuus Jan, 1863:11. Holotype: MNHN 928. Type locality: "Madagascar." Synonymy fide Boettger, 1879:459.

Typhlops (Typhlops) accedens Jan, 1863: 12. Holotype: MSNM, destroyed in WW II. Type locality: unknown; East Indies fide Hahn, 1980:39. Synonymy fide Peters, 1865: 263. Recognized as valid species by Boulenger (1893: 17).

Tortrix russellii, Günther, 1864:175. [unjustified emendation]

Typhlops accedens, Jan and Sordelli, 1864:3.

Typhlops capensis, Peters, 1869:139.

Typhlops flavoterminatus, Günther, 1870:139.

Typhlops inconspicuus, Boettger, 1879:459.

Typhlops bramini, Boettger, 1881:650. [unjustified emendation]

Typhlops (Typhlops) euproctus Boettger, 1882: 479. Holotype: SMF 16571. Type locality: "Lukubé, insula Nossi-Bé, Madagascariensis" [= Lokobe, Nosy Be Island, W Antsiranana Province, N Madagascar]. Synonymy fide Boulenger, 1893:16.

Typhlops bramino, Boettger, 1882:479. [unjustified emendation]

Typhlops sp. (braminus var.?), Müller, 1887:259.

Typhlops brahminus, Phipson, 1888:49. [unjustified emendation]

? *Typhlops sp.,* Okada, 1891:68.

Typhlops euproctus, Boulenger, 1893:16.

Tortrix russellii, Boulenger, 1893:16. [unjustified emendation]

Typhlops russellii, Boulenger, 1893:16. [unjustified emendation]

Cyphlops braminus, Cardew, 1897:592. [error typographicus]

Typhlops bramimus, Méhelÿ, 1897:62. [error typographicus]

Typhlops bramina, Hassert, 1903:25. [unjustified emendation]

Typhlops braminus arenicola Annandale, 1906:192. Syntypes (3): BMNH 1946.1.11.64 and ZSI 15457–58. Type locality: not stated; "Rámanád, Tamil Nadu State, southern India" fide Das and Gayen, 2004:97. Synonymy fide Bourret,

Table 6. Comparison of *Ramphotyphlops braminus* (bram) with other typhlopid genera. ACU = *Acutotyphlops*, AUST = *Austrotyphlops*, CATH = *Cathetorhinus*, CYC = *Cyclotyphlops*, GRY = *Grypotyphlops*, LETH = *Letheobia*, RHI = *Rhinotyphlops* + *Typhlops* (Africa), TYP = *Typhlops* (Asia), TYPH = *Typhlops* (New World), XENO = *Xenotyphlops*, Afr. = Africa, Aust. = Australia + PNG, E. I. = East Indies + SE Asia, Mad. = Madagascar, N. W. = New World, O. W. = Old World, Pan = Pantropical, PNG = Papua New Guinea, Sula. = Sulawesi. When multiple characters states occur in one taxon (+ = present, 0 = absent): most common state listed first and separated by comma from least common state, a slash separates states of nearly equal occurrence (40-60%), rare occurrence (< 10%) denoted parenthetically.

Genus	bram	TYP	RAM	AUST	CYC	ACU	RHI	TYPH	CATH	GRY	LETH	XEN
Character ▾ / Range ▸	Pan	Asia	E. I.	Aust.	Sula.	PNG	Afr.	N. W.	O. W.	India	Afr.	Mad.
Number of species	1	92	21	42	1	5	27	53	1	1	36	2
Parthenogenetic	+	0	0	0	?	0	0	0	?	0	0	?
Maximum length (mm)	203	600	480	700	146	487	950	522	183	631	550	263
Length/width ratio	30-60	20-130	18-104	20-120	32	18-58	18-57	16-77	92	38-79	27-129	64-86
Supralabial pattern	III	III, V (II)	III (0)	III	III	III, 0	II/0	III	II	0	0 (II)	0
Midbody scale rows	20	18-28	20-24	18-22	22	28-34	22-34	18-22	18	26	20-26	20-22
" " "		(16-30)	(18-30)	(16-24)		(26-36)	(18-44)	(16-24)		(24-34)	(18-30)	
Ant.-post. reduction > 1	0	0/+	0 (+)	0	0	+	+	0 (+)	0	+	+	0/+
Total middorsals	261-368	216-600	209-709	263-750	299	334-526	234-624	195-566	524	448-526	311-737	469-482
Total subcaudals	8-15	5-28	7-45	8-29	15	12-30	5-13	5-16	20	7-13	5-17	20-22
Relative tail length (%)	1.4-3.0	0.9-5.1	1.3-9.0	0.9-6.4	3.1	1.0-7.7	0.8-2.9	0.7-5.0	2.7	0.8-1.9	0.7-2.6	3.1-3.7
Eye visible	+	+	+ (0)	+ (0)	0	+	+	+	+	0 (+)	0 (+)	0
Ven. rostral keel/beak	0	0	0 (+)	0 (+)	0	0	0 (+)	0	+	+	0	+
Preocular	+	+	+ (0)	+	0	+	+	+	0	+	+ (0)	0
Postoculars	1	1-3 (4)	2-3 (1, 4)	1-3 (4)	3	3-5	3-5 (2, 7)	1-2 (3)	1	3-4	2-4 (5-6)	2-3
Helical hemipenis	?	0	+	+	?	+	0	0	?	0	0	?
Relative rostral width (%)	30-33	25-65	35-65	25-75	45	10-25	50-70	20-45	70	50-80	45-85	70-85
SNS complete dorsally	+	0 (+)	0 (+)	0	0	0	0	0	0	0	0	0
INS contacts preocular	+	0 (+)	0	0 (+)	0	0	0	0	0	0	0	0

Table 7. Comparison of mean visceral values of *Ramphotyphlops braminus* with other Asian typhlopid species groups (sample size in parentheses). RB = *braminus*, RA = *albiceps*, RE = *exocoeti*, RF = *flaviventer*, RL = *lineatus*, RM = *multilineatus*, RP = *polygrammicus*, AS = *subocularis*, CD = *Cyclotyphlops*, TA = *Typhlops ater* group, TD = *Typhlops diardii* group, TP = *Typhlops porrectus* group, TR = *Typhlops ruficaudus* group.

Character	RB (13)	RA (12)	RE (2)	RF (22)	RL (4)	RM (8)	RP (33)	AS (54)	CD (1)	TA (24)	TD (16)	TP (11)	TR (14)
SHYHG	0.42	0.35	0.30	0.29	0.28	0.32	0.35	0.43	0.44	0.36	0.43	0.42	0.19
HGBG	37.0	32.9	32.1	31.3	35.4	30.4	33.0	27.8	30.2	34.9	33.6	34.0	29.2
LD	0.12	0.10	0.04	0.06	0.05	0.05	0.06	0.05	0.07	0.11	0.05	0.12	0.04
LGBG	9.5	4.6	7.5	3.6	8.7	3.5	4.7	3.8	3.2	5.2	4.8	8.5	?
RAMP	62.9	84.4	84.9	71.2	86.7	68.9	77.2	76.4	84.9	69.4	65.9	68.4	?
TAMP	64.3	85.1	86.1	72.3	76.6	70.1	78.5	77.3	86.2	70.5	67.1	69.4	?
TTR	216	261	323	287	314	365	272	322	?	248	228	222	328
NTR	68	83	109	78	93	107	84	83	?	78	66	68	91
IPB	6.3	10.8	10.3	12.3	7.9	11.7	7.5	12.0	11.9	12.9	5.2	9.8	12.1
IPBPT	39.9	43.7	40.7	50.4	43.3	47.2	41.3	52.0	47.5	46.2	41.6	43.3	49.6
TB	38.2	42.6	39.9	49.1	42.2	46.1	40.1	51.0	46.4	45.3	39.8	42.4	48.4
IPB/RL	0.23	0.63	0.73	0.64	0.51	0.56	0.39	0.71	0.73	0.72	0.24	0.66	0.64
TMP-AMP	46.6	68.1	70.5	52.6	70.2	64.1	61.6	56.8	67.9	53.3	48.0	52.2	?
RLMP-AMP	21.8	43.7	48.6	24.3	45.8	36.4	35.3	28.8	42.5	28.2	20.1	28.4	?
TBMP-GBMP	50.8	44.0	42.6	44.5	49.3	42.5	46.3	42.2	42.2	45.5	49.3	46.0	42.4
HMP-RGMP	34.2	41.4	54.0	40.7	52.0	34.6	44.3	38.0	49.4	50.4	44.2	33.0	35.2

Key to abbreviations: SHYHG = sternohyoideus-heart gap, HGBG = heart-gall bladder gap, LD = liver difference (left and right liver midpoint difference/total liver length, LGBG = liver-gall bladder gap, RAMP = right adrenal midpoint, TAMP = total (left + right) adrenal midpoint, TTR = estimated number of tracheal rings, NTR = number of tracheal rings/10% SVL, IPB = intrapulmonary (right) bronchus length, IPBPT = bronchus posterior tip, TB = trachea + bronchus length, IPB/RL = bronchus length/right lung length, TMP-AMP = trachea midpoint-total (left + right) adrenal midpoint distance, RLMP-AMP = right liver midpoint-total (left + right) adrenal midpoint distance, TBMP-GBMP = trachea/bronchus midpoint-gall bladder midpoint distance, HMP-RGMP = heart midpoint-right gonad midpoint distance.

1936:11. Probably a valid species fide A. H. Wynn (pers. comm.).

Typhlops limbrickii Annandale, 1906:193, pl. 9, figs. 3–3a. Syntypes (2): ZSI 15460. Type locality: "Rámanád, [Tamil Nadu State], southern India." Synonymy fide Wall, 1909:60 & 1923a:349. Probably a valid species fide A. H. Wynn (pers. comm.).

Typhlops braminus pallidus Wall, 1909:609. Holotype: not located. Type locality: "Dibrugarh, south bank of Brahmaputra [River], Upper Assam, India." Synonymy fide Loveridge, 1957:244.

Glauconia Braueri Sternfeld, 1910:69. Holotype: ZMB 20728. Type locality: "Bagamoyo, Deutsch-Ostafrika" [= Tanzania]. Synonymy fide Boulenger, 1910:29.

Tyhlops braminus, Oshima, 1910:186. [error typographicus]

Typhlops braueri, Boulenger, 1910:29.

Typhlopidae braminus, Roux, 1911:498. [error typographicus]

Typhlops braminis, Montague, 1914:643. [error typographicus]

Typhlops fletcheri Wall, 1919:556, pl. 1 (upper right). Holotype: not located. Type locality: "Nilgiri Hills, India." Synonymy fide Wall, 1923a:349 and 1923b:253.

Typhlops bramini, Holtzinger-Tenever, 1920:102. [unjustified emendation]

Typhlops sp. ?, Gharpurey, 1927:224.

Typhlops braminus braminus, Mertens, 1930:278.

Typhlops sp., Purachatra, 1930:60.

Typhlops braminius, Gharpurey, 1932:272. [error typographicus]

Typhlopidae sp., Gharpurey, 1935:272.

Typhlopus braminus, Nakamura, 1938:192. [error typographicus]

Typhlops inconspiuous, Loveridge, 1957:244. [unjustified emendation]

Typhlops khoratensis Taylor, 1962:248, fig. 13A. Holotype: FMNH 178263. Type locality: "Muak Lek, Friendship Highway, Sara Buri Province, Thailand." Synonymy fide present publication.

Typhlops koratensis, Taylor, 1965:645. [error typographicus]

Ramphotyphlops braminus, Robb, 1966:675.

Typhlops barminus, Tayless, 1968:24. [error typographicus]

Typhlops pseudosaurus Dryden and Taylor, 1969:270. Holotype: FMNH 189357. Type locality: "Harmon Village, Guam, Mariana Islands." Synonymy fide Pregill, 1998:72 and Crombie and Pregill, 1999:67.

Ehyx braminus, Agrawal, 1970:41. [error typographicus]

Typhlops braminae, Brown and Alcala, 1970:114. [unjustified emendation]

Typhlops braminueus, Gallagher, 1971:27. [error typographicus]

Typhlops cf. *braminus,* Cheke, 1973:469.

T. braminus, Fleming & Bergsaker, 1974:5.

Typhlina (?) *bramina,* McDowell, 1974:22.

Typhlina bramina, Broadley, 1974:24–26.

Typhlops Graminas, Agarwal, 1979:9. [error typographicus]

Ramphothyphlops (Typhlina) braminus, Dixon and Hendricks, 1979:29. [error typographicus]

Rhamphotyphlops braminus, Feare, 1979:9. [unjustified emendation]

Typhlina braminus, Dixon and Hendricks, 1979:29.

Typhlina bramina bramina, Auffenberg, 1980:113.

Typhlops russelli, Hahn, 1980:39.

Typhlophs braminus, Majupuria, 1981:173. [error typographicus]

Ramphotyphlops bramina, Wilson and Porras, 1983:55.

Ramphotyphlopus braminus, Gibbons, 1985:139. [error typographicus]

Rhamphotyphlops braminus, Bosch, 1985:6. [incorrect subsequent spelling]

Thyphlops braminus, Tiwari, 1985:226. [error typographicus]

Ramphotyphlops braminaes, Brown and Alcala, 1986:78 & 82. [unjustified emendation]

Typhlops Braminius, Chaudhari, 1986:107. [unjustified emendation]

Typhlops (Rhamphotyphlops) braminus, Dessauer et al., 1987:21, fig. 8.

Ramphotyhlops braminus, Dodd, 1987:484. [error typographicus]

Rhamphotyphlops (?) *braminus,* Nanhoe and Ouboter, 1987:45. [incorrect subsequent spelling]

Rhamphotyphlos braminus, Mori et al., 1989:434. [error typographicus]

Rhamphotypholops braminus, Nutphand, 1990:49–50. [error typographicus]

Typlos braminus, Sarker, 1990:28. [error typographicus]

Rhamphotyphlops bramina, Brazaitis and Watanabe, 1992:135.

Remphotyphlops braminus, Hikida et al., 1992:32. [error typographicus]

Ramphotyphops braminus, Shi, 1993:330. [error typographicus]

Rhamphotyphlops (Typhlops) braminus, Vyas, 1993:179.

Typhlops fletaneri, Vyas, 1993:45. [error typographicus]

"Blind snake," Huang and Bai, 1993: frontispiece.

Leptotyphlops braminus, Krakauer, 1994:1. [lapsus calami]

Rhamphotyphlina bramina, Auffenberg, 1994:264. [unjustified emendation]

"Common blind snake," De, 1994:43.

Ramphyotyphlops [sic] *braminus,* Husain & Ray, 1995:160.

Ramphotyphlops Braminus, Murthy, 1995:78.

Ramphotyphlops bra-minus, Allison, 1996:427. [error typographicus]

Ramphotyphlops brahminus, Asokan, 1996:18. [unjustified emendation]

Ramphopyphlops braminus, Das, 1996:32. [error typographicus]

Ramphotypholops braminus, Nguyen & Ho, 1996:52. [error typographicus]

Rhamphotyphops braminus, Boonyawat, 1997:54. [error typographicus]

Ramphotyphlos braminus, Budha et al., 1998:82. [error typographicus]

Rhamphotyphlops (Typhlopa) braminus, Shrestra, 1998:46. [error typographicus]

Typlina bramina, Velmani, 1998:30. [error typographicus]

Eamphotyphlops braminus, Ye et al., 1998:5. [error typographicus]

Typhlopid (parthenogenetic), Gans, 1998:103.

Eryx bramicus, McDiarmid et al., 1999:60.

Typhlops (Ramphotyphlops) braminus, Meirte, 1999:221.

Ramphotyohlops braminus, Ota and Endo, 1999:246. [error typographicus]

Ramphotyphlos bramius, Chadra & Kar, 1999:141. [error typographicus]

Ramphotyphlops raminus, Crother, 2000:69. [error typographicus]

Ramphotyphlops bmminus, Zhong, 2000:38. [error typographicus]

Rhamphotyplops braminus, Daniels, 2001:300. [error typographicus]

Ramphotyphlops cf. *braminus,* Grismer et al., 2001:352.

Ramphothyphlops braminus, Mendoza-Quijano et al., 2001:241. [error typographicus]

Ramphotyphiops braminus, Baker, 2002:2. [error typographicus]

Ramphotyplops braminus, Sanyal et al., 2002:168. [error typographicus]

Ramphotypholops sp., Sharma, 2002:65. [error typographicus]

Typhlops-braminus, Mitra, 2002:329.

Ramphytophlops braminus, Morrison, 2003:94. [error typographicus]

Ramphotyphlops (Typhlops) braminus, Shrestha, 2003:444.

Ranphotyphlops braminus, Alcala et al., 2004:259. [error typographicus]

Ramphotyphlops sp., Vidal & Hedges, 2004:S227.

Ramphotyphlopus braminus, Asiatic lion, 2006. [error typographicus]

The following 15 names were previously considered synonyms of *Typhlops braminus* Daudin but currently are considered to include 10 valid species and five synonyms of other species.

Typhlops tenuis Günther, 1864:176. [preoccupied by *Typhlops tenuis* Salvin, 1860; = *T. pammeces* Günther, 1864:444]. Listed as a synonym of *T. braminus* by Peters (1865:263), Blanford (1870:370), Boulenger (1893:16), Wall (1921:9) and Bourret (1936:11).

Typhlops pammeces Günther, 1864:444. Listed as a synonym of *T. braminus* by Peters (1865:263), Blanford (1870:370), Boettger (1889:300), Boulenger (1893:16), Wall (1921:9), Loveridge (1957:244) and Mahendra (1984:41). Recognized as a valid species by Stoliczka (1871:426) and Smith (1943:48).

Typhlops reuteri Boettger, 1881:650. Listed as a synonym of *T. braminus* by Boulenger (1893:16), Wall (1921:9) and Schleich and Kästle (2002:993). Recognized as a valid species by Boettger (1889:300, 1898:2), Mocquard (1909:37), Blanc (1971:111) and Guibé (1958:192).

Typhlops lenzi Boettger, 1882:478 [= *Typhlops reuteri* Boettger, 1881, fide Hahn, 1980:69]. Listed as a synonym of *T. braminus* by Wall (1921:9) and a questionable synonym by Boulenger (1893:16).

Typhlops comorensis Boulenger, 1889:361. Listed as a synonym of *T. braminus* by Loveridge (1957:244). Recognized as a valid species by Roux-Estève (1974:28, 250).

Typhlops beddomii Boulenger, 1890:237. Listed as a synonym of *T. braminus* by Bourret (1936:11) and Hahn (1980:39). Recognized as a valid species by Boulenger (1893:18), McDowell (1974:15) and McDiarmid et al. (1999:91).

Typhlops psammophilus Annandale, 1906:193 [= *Typhlops pammeces* Günther, 1864 fide Smith, 1943:48]. Listed as a synonym of *T. braminus* by Wall (1923a:349) and Smith (1943:48).

Typhlops microcephalus Werner, 1909:60. Listed as a synonym of *T. braminus* by Loveridge (1957:244), Hahn (1980:39) and Brygoo (1987:23). Recognized as a valid species by Guibé (1958:194), Blanc (1971:111), Meirte (1992:21) and Wallach in McDiarmid et al. (1999:60).

Typhlops capensis Rendahl, 1918:1. [= *Ramphotyphlops exocoeti* Boulenger, 1887 fide Wallach, unpubl. data]. Listed as a synonym of *T. braminus* by Loveridge (1957:245) and as a synonym of *T. comorensis* Boulenger, 1889 by Roux-Estève (1974:28, 250).

Typhlops malaisei Rendahl, 1937. [= *Ramphotyphlops albiceps* Boulenger, 1898 fide Hahn, 1980:38]. Listed as a synonym of *T. braminus* by Mahendra (1984:41).

Typhlops lankaensis Taylor, 1947:287. Listed as a synonym of *T. braminus* by Mahendra (1984:43). Recognized as a valid species by Hahn (1980:61).

Typhlops violaceus Taylor, 1947:289. Listed as a synonym of *T. braminus* by Mahendra (1984:43). Recognized as a valid species by Hahn (1980:76) and Silva (1982).

Typhlops malcolmi Taylor, 1947:291. Listed as a synonym of *T. braminus* by Mahendra (1984:43). Recognized as a valid species by Hahn (1980:64) and Silva (1982).

Typhlops tenebrarum Taylor, 1947:292. Listed as a synonym of *T. braminus* by Mahendra (1984:43). Recognized as a valid species by Hahn (1980:73) and Silva (1982).

Typhlops veddae Taylor, 1947:294. Listed as a synonym of *T. braminus* by Mahendra (1984:43). Recognized as a valid species by Hahn (1980:75) and Silva (1982).

Diagnosis.– *Ramphotyphlops braminus* is distinguished from all other members of the Typhlopidae by the combination of the inferior nasal suture in contact with the preocular shield, the superior nasal suture extending onto the dorsum of the snout to contact the rostral and greater than 270 middorsal scales. Alternatively, it is separable from all Serpentes in being a unisexual, obligate parthenogen and having point contact of the ventral scales, each of which has a black spot anteriorly.

Distribution

Cosmopolitan distribution in Old World tropical and subtropical regions with encroachment into the Northern Hemisphere of the New World and adjacent temperate areas (probably native to Sri Lanka or southern India). *Ramphotyphlops braminus* is native or indigenous to southern and eastern Asia but it is invasive in many parts of the world and naturalized in most of those areas (Pysek et al., 2008).

Based upon published literature and voucher specimen records, *Ramphotyphlops braminus* is known from the following 84 countries (with islands or archipelagos listed in square brackets and islets within the former listed in curly brackets), presented in alphabetical order by geographic region. A '?' preceeding a name indicates probable or questionable—but as of yet unconfirmed—presence.

1) SOUTHERN ASIA: Afghanistan, Bahrain [Muharraq], Bangladesh [Hatiya], Bhutan, India [Barkuda, Cochin Willingdon, Neil], Iran, Iraq, Kuwait, Nepal,

Oman, Pakistan, Saudi Arabia, South Yemen, Sri Lanka and United Arab Emirates [Dubai].

2) INDOCHINA: Burma, Cambodia, Laos, Thailand [Phuket, Salanga, Samet] and Vietnam [Cat Ba, Condor, Cu Lao Phon Vong, Hon Nor Way].
3) EAST ASIA: China [Guan Yu, Hainan, Matsu, Nan Ao, Ping Yu], Hong Kong [Chek Lap Kok, Cheung Chau, Hei Ling Chau, Hong Kong, Kat O Chau, Kau Yi Chau, Lamma, Lantau, Ma Wan, Po Toi, Shek Kwu Chau, Soko, Stonecutters, Tai Lei, Tung Ping Chau, Yim Tin Tsai], Japan [Agunijima, Akajima, Akusekijima, Amamioshima, Amurojima, Aragusukujima, Chichijima, Kita-Daitojima, Okino-Daitojima, Fukajijima, Gishifujima, Gushikawajima, Gusukujima, Hachijojima, Hamahigajima, Hatejima, Haterumajima, Hatizyozima, Hyanzajima, Iejima, Iheyajima, Ikeijima, Ikemajima, Irabujima, Iriomotejima, Ishigakijima, Izenajima, Kakeromajima, Kamiyamajima, Kayamajima, Kerumajima, Kikaijima, Kikaigashima, Kobijima, Kodakarajima, Kohamajima, Kita-Kojima, Minami-Kojima, Korijima, Kubajima, Kudakajima, Kumejima, Kurimajima, Kuroshima, Kyushu, Maejima, Minnajima, Miyagijima, Miyakojima, Nakajima, ? Nakanokamishima, Nanseisyotou, Nohojima, Ogamijima, Ogasawara, Ohajima, Ojima, Okierabujima, Okinawajima, Sakishima, Sesokojima, Shimojishima, Takarajima, Taketomijima, Tanegashima, Taramajima, Tokashikijima, Tokunoshima, Tonakijima, Tsukenjima, Ukejima, Ukibarujima, Uotsurijima, Yabuchijima, Yaguchijima, Yakabijima, Yanahajima, Yonagunijima, Yorojima, Yoronjima, Zamamijima], Macau [Coloane, Taipa], Philippines [Agutayan, Apo, Bantayan, Barit, Basilan, Batan, Bohol, Bongao, Borocay, Busuanga, Calauit, Camiguin, Catanduanes, Cebu, Corregidor, Dalupiri, Gigante South, Grande, Guimaras, Ibuhos, Jolo, Lapinin Chico, Leyte, Luzon, Mactan, Marinduque, Masbate, Maybag, Mindanao, Mindoro, Negros, Pacijan, Palawan, Pamilacan, Panay, Panubulon, Polillo, Ponson, Samar, Semirara, Sibay, Sibuyan, Tintiman] and Taiwan [Chihmei, Lanyu].
4) INDIAN OCEAN: Andamans [North Andaman, South Andaman], Comoros [Anjouan, Mayotte, Mohéli], Laccadives [Minikoi], Madagascar [Nosy Bé], Maldives [Girawa, Miladumadulu], Mascarenes [Mauritius {Aigrettes, Fourneaux, Marginay, La Passe, Plate, Round}, Réunion, Rodrigues {Cocos, Hermitage}], Nicobars [Car Nicobar, Chowra, Great Nicobar, Katchall, Tarasa] and Seychelles [Aride, Assumption, Bird, Cerf, Cousin, Cousine, Curieuse, Fregate, Ilot, La Digue, Mahé, Praslin, Silhouette].
5) EAST INDIES: Australia [Bathurst, Christmas, Cocos-Keeling {Panjang, Selma, West}, Thursday, Melville], Borneo {Brunei Darussalam, Indonesian Kalimantan, Sabah, Sarawak}, Indonesia [Ambon, Bali, Bangka, Batjan, Belitung, Butung, Flores, Java, Komodo, Krakatau {Sertung}, Lomblen, Lombok, Madura, Maluku {Aru, Buru, Halmahera, Kai, Seram, Ternate}, Nias, Nila, Postiljon, Riau, Sabalana, Saparua, ? Sebesi, Sulawesi {Buton, Hoga, Kabaena, Selayar}, Sumatera, Sumba, Sumbawa, Timor, Weh], Malaysia [Aceh, Aur, Babi Besar, Dayang, Langkawi, Penang, Sibu, Sibu Tengah, Tioman, Tunas Selatan], Singapore [Ubin], New Guinea and Solomons [Bougainville, Gizo, Guadalcanal, Indonesian Irian Jaya, Kar Kar, New Britain, Nusa Tupe, Trobriands {Kiriwina}, Tulaghi].
6) PACIFIC OCEAN: American Samoa [Ta'u, Tutuila], Fiji [? Taveuni, Viti Levu], Hawaii {Hawaii, Kahoolawe, Kauai, Lanai, Maui, Molokai, Oahu}, Kiribati, Loyalty [Maré], Marianas [Agrihan, Aguiguan, Alamagan, Anatahan, Guam, Pagan, Rota, Saipan, Sarigan, Tinian], Marshalls [Enewetak, Jaluit, Kwajalein, Medren, Parry], Federated States of Micronesia [Lenger, Ponhpei {Mwahnd Peidi}, Sokehs, Yap], Midway [Sand], Nauru, New Caledonia [Grand Terre, Pins], New Zealand, Palau [Babeldaob, Carp, Koror/Oreor, Malakal, Ngcheangel,

Ngeaur, Ngedbus, Ngerekebesang, Ngetmeduch] and Vanuatu [Efaté, Espiritu Santo].

7) AFRICA: Benin, Burkina Faso, Cameroon, Canaries [Grand Canary], Central African Republic, Congo, Egypt, Equatorial Guinea [Annobon], Gabon, Ivory Coast, Kenya, Mauritania, Mozambique, Nigeria, Sénégal, Somalia, South Africa, Tanzania [Pemba, Zanzibar] and Togo.
8) NEW WORLD: ? Belize [? Turneffe], British West Indies [Grand Cayman], El Salvador, Guatemala, Lesser Antilles [Anguilla, St. Barthélemy, St. Martin], Mexico, Netherlands Antilles [Aruba, Curaçao] and USA [Alabama, ? Arizona, ? California, Florida {Marco, Sanibel, Stock}, Georgia, Louisiana, Massachusetts, Minnesota, Ohio, Texas, Virginia].

Ramphotyphlops braminus is generally found at low elevations, from sea level to 300 m, although in some places it reaches more than 1000 m and has been recorded up to 2000 m in Bali (McKay, 2006), 2150 m in México (Eliosa-León et al., 1995) and 2600 m in Papua New Guinea (O'Shea, 1996). Following are the known elevational ranges of *R. braminus* from the literature and voucher specimens, rounded off to the nearest 5 m. Countries (and islands) are listed in alphabetical order: Bhutan (200–400 m), Burma (110–1450 m), Cambodia (500–1640 m), Cameroon (5 m), China (5–1300 m), El Salvador (700 m), Guatemala (60–1500 m), Hawaii (5–365 m), Hong Kong (0–600 m), India (0–1515 m), Indonesia (0–2000 m), Japan (0–60 m), Laos (100 m), Macau (60 m), Madagascar (200–1200 m), Malaysia (0–1040 m), Marianas (65–90 m), Mascarenes (0–350 m), México (0–2150 m), Micronesia (5–30 m), Nepal (100–1500 m), New Caledonia (0–360 m), Pakistan (215 m), Palau (20–30 m), Papua New Guinea (45–2600 m), Philippines (0–1100 m), Saudi Arabia (0–2100 m), Seychelles (0–205 m), South Africa (0–50 m), Sri Lanka (0–1200 m), Taiwan (150–1000 m), Thailand (100–300 m) and Vietnam (90–165 m).

Discussion

As is apparent from the above synonymy, the status and relationships of *Ramphotyphlops braminus* have been unsettled. A new monotypic genus was going to be proposed herein for *R. braminus* to reflect its uniqueness but A. H. Wynn (USNM) has been studying *Ramphotyphlops braminus* and its relationship to members of the *Typhlops pammeces* group for some time and will be presenting a more thorough analysis at a later date so I defer to him and his ongoing work for the transfer of *R. braminus* to a new genus.

Ramphotyphlops braminus is a small, nondescript blindsnake that is often mistaken for a worm and sometimes confused with other small typhlopids. However, it is a successful colonist and human commensal and as such, has dispersed throughout the tropical and subtropical world except in South America. As a non-venomous predator mainly upon ants and termites, *Ramphotyphlops braminus* is a benign snake that is beneficial to the agricultural, horticultural and architectural economies/businesses worldwide.

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Taxonomic status of *Cyrtodactylus khasiensis tamaiensis* (Smith, 1940) and description of a new species allied to *C. chrysopylos* Bauer, 2003 from Myanmar (Reptilia: Gekkonidae)

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(with three text-figures)

ABSTRACT.– ***Cyrtodactylus khasiensis tamaiensis* was described based on a unique specimen from north-eastern Myanmar. The holotype is redescribed, and the taxon elevated to species status based on distinct and in part overlooked differences compared with the nominal form. Diagnostic characters of *C. tamaiensis* are as follows: 40 precloacal-femoral pores in an almost continuous series, femoral pore-bearing scales slightly enlarged, a distinct patch of enlarged scales between pore bearing scales and cloaca, no cloacal groove, 37 midventral scale rows, 21 longitudinal, non-linear rows of enlarged tubercles middorsally, transversely enlarged row of subcaudals absent, 16 complete lamellae under 4th digit of pes, and dorsal body pattern consisting of contrasting dense pale and dark brown marbling. An additional species previously confused with *C. khasiensis* from Myanmar is described herein as *Cyrtodactylus mandalayensis* sp. nov. It can be distinguished from congeners by the following combination of characters: 5 precloacal pores in a continuous wide angular series with a single additional enlarged pored scale bordering posteriorly apex of series angle, pore-bearing scales of continuous series slightly enlarged relative to anteriorly adjacent ventrals, a distinct patch of slightly enlarged scales between pore-bearing scales and cloaca, cloacal groove, enlarged femorals and transversely enlarged subcaudals absent, 32 midventral scale rows, 18 longitudinal, non-linear rows of enlarged tubercles middorsally, 18 complete lamellae under 4th digit of pes, and dorsal body pattern consisting of irregular dark brown blotches on a pale brown background. *C. khasiensis* is removed from the checklist of Myanmar herpetofauna, restricting its range to India and southern China.**

KEY WORDS.– **Gekkonidae, *Cyrtodactylus khasiensis*, *C. mandalayensis* sp. nov., *C. tamaiensis* redescription, Myanmar.**

Introduction

The genus *Cyrtodactylus* Gray, 1827, is currently represented in Myanmar by 16 species, of which nine were only recently described and considered endemic. These species include the mainland species *C. aequalis* Bauer, 2003, *C. annandalei* Bauer, 2003, *C. ayeyarwadyensis* Bauer, 2003, *C. brevidactylus* Bauer, 2002, *C. chrysopylos* Bauer, 2003, *C. consobrinoides* (Annandale, 1905), *C. feae* (Boulenger, 1893), *C. gansi* Bauer, 2003, *C. khasiensis* (Jerdon, 1870), *C. oldhami* (Theobald, 1876), *C. peguensis* (Boulenger, 1893), *C. russelli* Bauer, 2003, *C. slowinskii* Bauer, 2002, *C. variegatus* (Blyth, 1859) and *C. wakeorum* Bauer, 2003 and one insular species *C. rubidus* (Blyth, 1861) from the Cocos Island Group of the Andaman Islands, presently under the administration of Myanmar.

The species *Pentadactylus khasiensis* (Jerdon, 1870) was originally described from specimens collected in the Khasi Hills of Meghalaya, north-east India. The genus *Pentadactylus*

(Gray, 1845) is currently a synonym of *Hoplodactylus* Fitzinger, 1843. *P. khasiensis* was later transferred to *Gymnodactylus* Spix, 1825, by Boulenger (1885), and then transferred to the resurrected genus *Cyrtodactylus* by Underwood (1954). Smith (1935) significantly extended the range of *C. khasiensis* reporting additional records from Burma (currently Myanmar) based on specimens deposited at The Natural History Museum, London (= BMNH). One specimen from north-eastern Myanmar was considered to differ from typical *C. khasiensis* only by the number of precloacal-femoral pores and was briefly described as *Gymnodactylus khasiensis tamaiensis* Smith, 1940. Since its description, no further collection of this taxon has been recorded in the literature. Recently, a new subspecies, *C. khasiensis cayuensis* Li, 2007, has been described from Cayu County, Xizang, China. The diagnosis (in English) provided for this subspecies overlaps with that of *C. khasiensis* in all characters mentioned with the exception of its lower precloacal pore count. *Cyrtodactylus chrysopylos* is another poorly known species described from a single specimen collected from Panlaung–Pyadalin Cave Wildlife Sanctuary in Shan State of eastern Myanmar (Bauer, 2003).

While examining Myanmar specimens referred to *C. khasiensis* at the collection of the Natural History Museum, London, the type specimen of *C. khasiensis tamaiensis* was found to be sufficiently different from topotype material of *C. khasiensis* to afford it species status. Another specimen labelled "*C. khasiensis*" was similar in meristic characters to *C. chrysopylos* but was considered to show sufficient differences from the holotype of *C. chrysopylos* to justify according it full specific status.

Materials and methods

Measurements were taken using a vernier caliper and rounded to the nearest 0.1 mm. Photographs of specimens were taken with a Panasonic Lumix FZ18 digital camera and meristic details were assessed with the aid of a Camera Lucida microscope. Details of elevation and GPS coordinates for localities provided herein were obtained from online gazetteers with the exception of the coordinates provided for Pangnamdim (Smith, 1940). Morphological and meristic abbreviations used in the text are as follows; SVL (snout to vent length), TTL (total tail length), RTL (length of regenerated tail portion), TW (maximum tail width), TD (maximum tail depth), TrL (trunk length from the axilla to the groin), HL (head length from posterior axis of the jaw to the tip of the snout), HW (head width at its widest point), JW (jaw width taken at the axis of the upper and lower jaws, posterior to the eye), HD (maximum head depth), OD (horizontal orbit diameter), EL (maximum ear diameter), OE (distance from posterior edge of the orbit to anterior edge of ear), OS (anterior edge of the orbit to snout tip), IN (internarial distance), IO (minimum distance between anterior supraciliaries), FAL (length from elbow to wrist), CL (crus length), IL (number of infralabials), and SL (number of supralabials). Comparative specimens were examined at The Natural History Museum, London (BMNH), Jahangirnagar University Herpetology Group (JUHG) and Zoological Survey of India, Kolkata (ZSI); see Appendix I. Additional information on morphological characters for species not examined were obtained from the following literature: Annandale, 1905; Batuwita and Bahir, 2005; Bauer, 2002, 2003; Bauer et al., 2003; Brown and McCoy, 1980; Darevsky, 1964; Darevsky and Szczerbak, 1997; Darevsky et al., 1997; Das, 1993, 1997, 2005; Das and Lim, 2000; David et al., 2004; Dring, 1979; Dunn, 1927; Grismer, 2005, 2008; Grismer and Ahmed, 2008; Grismer and Leong, 2005; Grismer et al., 2008; Günther and Rösler, 2002; Hayden et al., 2008; Heidrich et al., 2007; Hikida, 1990; Hoang et al., 2007; King, 1962; Kraus, 2008; Kraus and Allison, 2006; Li, 2007; Linkem et al., 2008; Nazarov et al., 2008; Ngo, 2008; Ngo and Bauer, 2008; Nguyen et al., 2006; Oliver, et al., 2008; Orlov et al., 2007; Pauwels et al., 2004; Rösler, 2001; Rösler and Glaw, 2008; Rösler et al., 2008; Schleich and Kästle, 2002; Smith, 1920, 1921, 1923, 1935; Taylor, 1962; Ulber, 1993; Ulber and Grossmann, 1991 and Youmans and Grismer, 2006. This species is compared to all species currently considered members of the genus *Cyrtodactylus* as listed by Uetz et al. (2008) with the exceptions of *C. aravallensis* Gill, 1997, *C. mansarulus* Duda and Sahi, 1978, *C. stoliczkai* (Steindachner, 1867), *C. tibetanus* (Boulenger, 1905) and *C. walli* (Ingoldby, 1922) which are likely members of *Cyrtopodion* s.l. and *C. col-*

legalensis (Beddome, 1870) and *C. nebulosus* (Beddome, 1870) which are variously regarded as members of *Geckoella*. Additionally the three species referred there to the genus *Gonydactylus*, are here considered members of *Cyrtodactylus*, *C. marcuscombaii* (Darevsky et al., 1998), *C. martinstolli* (Darevsky et al., 1998) and *C. nepalensis* (Schleich and Kästle, 1998), of which the former two species at least appear to be morphologically similar to members of the *Cyrtodactylus khasiensis* group of neighbouring north-eastern India. Generic placement of *Cyrtodactylus gordongekkoi* (Das, 1993) follows Biswas (2007).

Systematics

Cyrtodactylus tamaiensis (Smith, 1940)

(Figs. 1–2)

Gymnodactylus khasiensis tamaiensis: M. A. Smith, 1940:475. Type locality "Pangnamdim, Nam Tamai Valley [(27°42'N, 97°54'E), Upper Burma]".

[*Cyrtodactylus khasiensis*] *tamaiensis*: A. G. Kluge, 2001:7.

(Note: "*Gymnodactylus khasiensis*: M. A. Smith, 1935:53." was included in the original synonymy of the subspecies by Smith [1940]. However, in the former he does not describe or mention a specimen attributable to *C. tamaiensis*. Furthermore, the type and only known specimen was collected after 1935, thus his inclusion of Smith [1935] is incorrect in the original synonymy, and may be more accurately referred to as a chresonym (sensu Smith and Smith, 1972). For this reason, it is not included in the synonymy here.)

Holotype.– BMNH 1946.823.22 (formerly BMNH 1940.6.1.42), adult male; Pangnamdim, Nam Tamai Valley Burma. Collected by Ronald Kaulback, 1937–1939.

Condition.– The specimen is in overall good condition, tail is detached at fifth segment but present, a patch of scales on snout posterior to supranasals and internasal damaged. A midventral longitudinal incision on trunk.

Etymology.– The specific epithet is a toponym derived from the type locality in the Nam Tamai Valley.

Distribution.– *Cyrtodactylus tamaiensis* is known only from the holotype collected from "Pangnamdim, Nam Tamai Valley [(27°42'N, 97°54'E), Upper Burma]". Pangnamdim (~1166 m asl) is currently situated in Kachin State, northern Myanmar. The specimen was collected from a tree some 6 feet (= 1.8 m) from the ground (Smith, 1940).

Redescription of holotype.– Adult male, SVL 90.0 mm. Head moderately long (HL/SVL ratio 0.262), relatively wide (HW/HL ratio 0.712), somewhat depressed (HD/HL ratio 0.39), distinct from neck; loreal region weakly concave, interorbital area flat, canthus rostralis not well developed; snout moderately short (OS/HL ratio 0.367), a little longer than orbit diameter (OD/OS ratio 0.774); scales on snout and forehead rounded, granular, intermixed with scattered small tubercles posteriorly; scales on snout slightly larger than those on occipital region. Orbits large (OD/HL ratio 0.305); pupil vertical with crenelated margins; supraciliaries small, granular with no spines; ear opening oval, obliquely oriented, large (EL/HL ratio 0.072); orbit to ear distance slightly more than orbit diameter (OD/OE ratio 0.96). Rostral 61.1% as deep (2.2 mm) as wide (3.6 mm), widely bifurcate dorsally and with a very short rostral suture; two small supranasals separated by a single, large internasal completely filling space formed by dorsal bifurcation of rostral (Fig. 1B); rostral in contact with first supralabials, nasals, supranasals, and internasal; nostrils circular, laterally oriented, each in broad contact with rostral and also surrounded by supranasal, first supralabial, and three granular postnasals; 3–4 rows of scales separate orbit from supralabials; mental triangular, wider (3.6 mm) than deep (2.4 mm); one pair of greatly enlarged postmentals, each ca. 40% size of mental; left and right postmentals in broad medial contact with no intervening granules, each member of pair bordered laterally by first infralabial and an enlarged lateral chin shield, pair bordered posteriorly by 3–4 small granules (Fig. 1C); throat scales homogeneous, small, rounded and granular; enlarged supralabials to angle of jaws 10/10 (left/right); infralabials 9/9 (left/right), bordered by one row of enlarged scales, largest anteriorly; interorbital scale rows across narrowest point of frontal bone ~19.

Body moderately slender, relatively short (TrL/SVL ratio 0.41) with weak ventrolat-

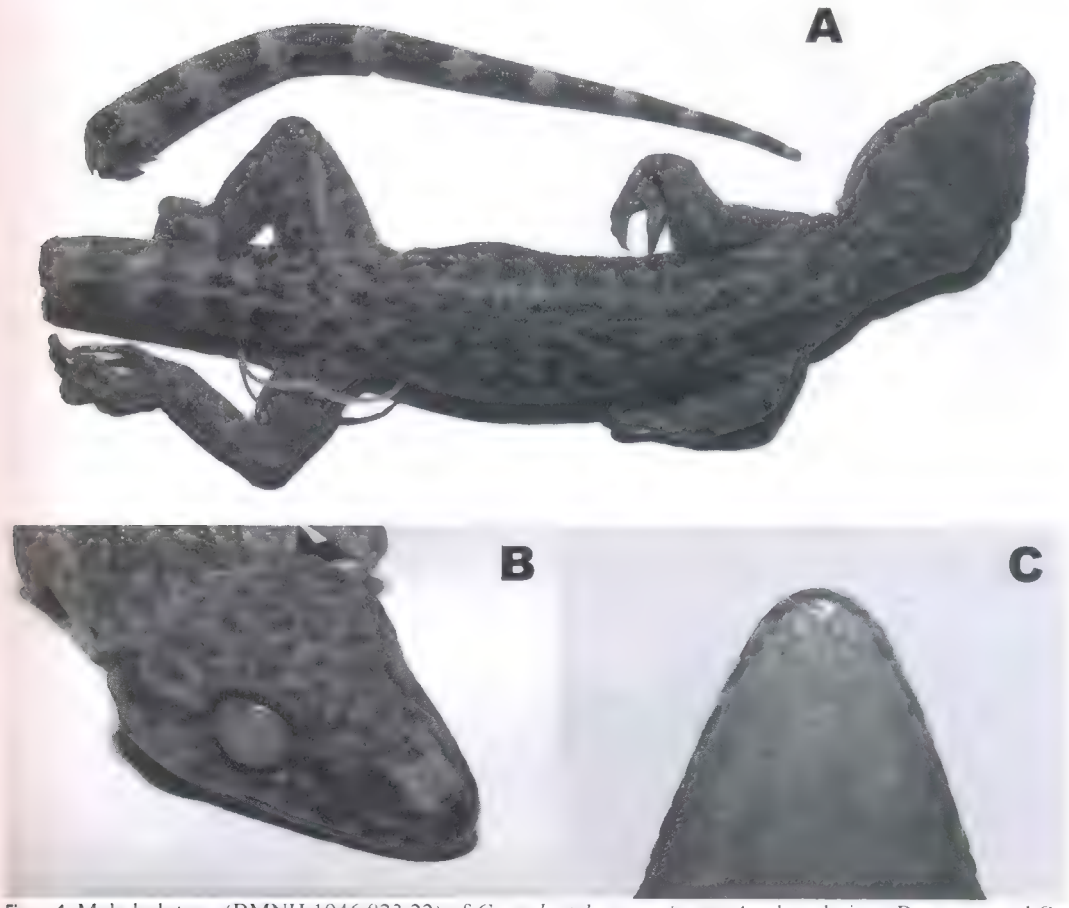

Figure 1. Male holotype (BMNH 1946.823.22) of *Cyrtodactylus tamaiensis*; A – dorsal view; B – snout; and C – gular view.

eral folds; dorsal scales heterogeneous, mostly rounded granules, intermixed with irregularly arranged small (2–4 times granule size) circular tubercles, bluntly conical to weakly keeled dorsally, becoming flat laterally, tubercles extend from frontal region to proximal third of tail; tubercles on nape considerably smaller then those of dorsum and those of tail completely flat; tubercles in approximately 21 non-linear longitudinal rows at midbody; 52 tubercles in paravertebral row from occiput to mid sacrum; ventral scales much larger than dorsals, cycloid, imbricate to subimbricate; enlarged under thighs and in a patch between precloacal pores and vent; midbody scale rows across belly between ventrolateral folds 37; scales on throat minute, granular, grading into larger scales on chest. 40 precloacal-femoral pores in an almost continuous series with exception of a single non pore-bearing scale, tenth from left in series, pore-bearing scales mostly slightly enlarged relative to anteriorly bordering ventrals (Fig. 2); no precloacal groove; a patch of enlarged scales border pored series posteriorly and medially; hemipenal bulge enlarged.

Fore and hind limbs relatively slender; forearm (FAL/SVL ratio 0.131) and tibia (CL/SVL ratio 0.176) relatively short; digits relatively short, strongly inflected at each joint, all bearing robust, recurved claws; subdigital lamellae widened beneath basal phalanx; lamellae from first proximal scansor greater than twice largest palm scale to basal-most digital inflection: 4–5–5–5–4 (manus) and 3–5–5–6–5 (pes); lamellae from basal-most digital inflection to digit tip, not including ventral claw sheath (intervening rows of nonlamellar granules between basal and distal lamellae series in parenthe-

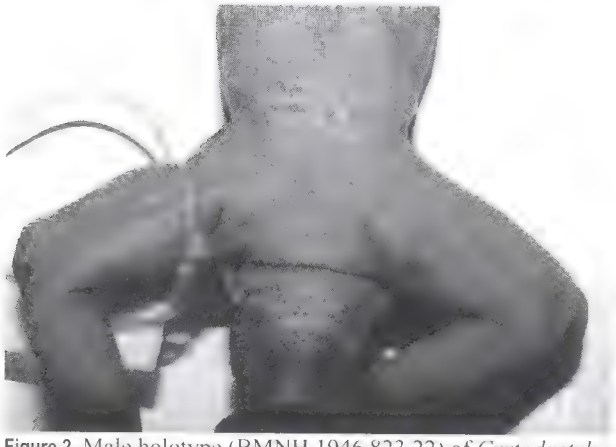

Figure 2. Male holotype (BMNH 1946.823.22) of *Cyrtodactylus tamaiensis*; view of the precloacal region.

sis): 6(2)–7(3)–11(2)–11(0)–9(2) (manus) and 8(0)–8(2)–11(1)–10(2)–12(0) (pes); interdigital webbing absent; relative length of digits (measurements in mm in parentheses): IV (8.7) > III (7.9) > II (7.3) > V (6.6) > I (4.7) (manus) and IV (10) > V (9.1) > III (8.2) = II (8.2) > I (5.3) (pes); scales on ventral manus and pes granular, smooth; scales on dorsal aspects of hind limbs granular, similar to dorsal scales, with larger, flat tubercles interspersed; dorsal scales of proximal forelimbs granular, without tubercles; scales of forearms heterogeneous with scattered, small, flat tubercles.

Complete original tail (broken but present) longer than body (TTL/SVL 1.144), slender, oval in cross section (TD/TW ratio 0.842); scales arranged in regular segments proximally; mostly rectangular with a single transverse row of 6–2 enlarged flat

Figure 3. Male holotype (BMNH 1900.9.20.1) of *Cyrtodactylus mandalayensis* sp. nov.; A– dorsal view; B – snout; and C– gular view.

tubercles along posterior edge of first five tail segments, separated from each other by three granular scales, beyond which segments become indistinguishable; basal segments dorsally with 8–9 transverse scale rows per segment, gradually increasing in size laterally to become 4 rows per segment ventrally; segments not strongly demarcated ventrally or posteriorly; no transversely enlarged median plates. Postcloacal spurs are 3/4 (left/right) enlarged, smooth, rounded scales on each side of tail base.

Colouration in preservative.– Forehead and hind limbs mid-brown with dark brown mottling; no nuchal collar present; dorsal body pattern from rear of head to sacrum is densely marbled with contrasting irregular pale brown and dark brown markings; posterior to sacrum, dorsal markings form more regular paired dark brown blotches which merge on posterior half of tail to form wide dark transverse bands (Fig. 1A), ventral surface of tail is mottled anteriorly and banded posteriorly; entire ventral surface of body, limbs, manus, pes, throat and chin plain pale yellowish-brown. No information was provided in the original description on colouration in life (Smith, 1940).

Comparisons.– This species is diagnosable from all congenerics by the following combination of characters: SVL 90 mm; 40 precloacal-femoral pores in an almost continuous series; femoral pore-bearing scales slightly enlarged; a distinct patch of enlarged scales between the pore-bearing scales and cloaca; no cloacal groove; 3–4 post cloacal spurs; 37 midventral scale rows; 21 longitudinal, non-linear rows of enlarged tubercles middorsally; transversely enlarged row of subcaudals absent; total of 16 complete lamellae under the 4th digit of the pes and dorsal body pattern consisting of contrasting dense pale and dark brown marbling.

Cyrtodactylus tamaiensis can be distinguished by the absence of enlarged subcaudal plates from *C. aaroni* Günther and Rösler, 2003, *C. aurensis* Grismer, 2005, *C. badenensis* Nguyen, Orlov and Darevsky, 2007, *C. baluensis* (Mocquard, 1890), *C. caovansungi* Orlov, Nguyen, Nazarov, Ananjeva and Nguyen, 2007, *C. chanhomeae* Bauer, Sumontha and Pauwels, 2003, *C. chauquangensis* Hoang, Orlov, Ananjeva, Johns, Hoang and Dau, 2007, *C. condorensis* (Smith, 1921), *C. consobrinoides* (Annandale, 1905), *C. consubrinus* (Peters, 1871), *C. cracens* Batuwita and Bahir, 2005, *C. deveti* (Brongersma, 1948), *C. edwardtaylori* Batuwita and Bahir, 2005, *C. epiroticus* Kraus, 2008, *C. feae* (Boulenger, 1893), *C. fraenatus* (Günther, 1864), *C. huynhi* Ngo and Bauer, 2008, *C. ingeri* Hikida, 1990, *C. interdigitalis* Ulber, 1993, *C. jarujini* Ulber, 1993, *C. klugei* Kraus, 2008, *C. macrotuberculatus* Grismer and Ahmed, 2008, *C. malcomsmithi* (Constable, 1949), *C. mimikanus* (Boulenger, 1914), *C. nigriocularis* Nguyen, Orlov and Darevsky, 2007, *C. oldhami* (Theobald, 1876), *C. paradoxus* (Darevsky and Szczerbak, 1997), *C. peguensis* (Boulenger, 1893), *C. phongnhakebangensis* Ziegler, Rösler, Herrmann and Vu, 2003, *C. pulchellus* Gray, 1827, *C. ramboda* Batuwita and Bahir, 2005, *C. redimiculus* King, 1962, *C. robustus* Kraus, 2008, *C. rubidus* (Blyth, 1861), *C. russelli* Bauer, 2003, *C. slowinskii* Bauer, 2002, *C. soba* Batuwita and Bahir, 2005, *C. solomonensis* Rösler, Richards and Günther, 2007, *C. subsolanus* Batuwita and Bahir, 2005, *C. sumonthai* Bauer, 2002, *C. takouensis* Ngo and Bauer, 2008, *C. thirakhupti* Pauwels, Bauer, Sumontha and Chanhome, 2004, *C. tigroides* Bauer, Sumontha and Pauwels, 2003 and *C. tripartitus* Kraus, 2008, *C. variegatus* (Blyth, 1859). From the following species which do not possess femoral pores in males; *C. adleri* Das, 1997, *C. angularis* (Smith, 1921), *C. annulatus* (Taylor, 1915), *C. brevidactylus* Bauer, 2002, *C. cavernicolus* Inger and King, 1961, *C. chrysopylos* Bauer, 2003, *C. cryptus* Heidrich, Rösler, Thanh, Böhme and Ziegler, 2007, *C. elok* Dring, 1979, *C. gordongekkoi* (Das, 1993), *C. hontreensis* Ngo, Grismer and Grismer, 2008, *C. intermedius* (Smith, 1917), *C. irianjayaensis* Rösler, 2001, *C. irregularis* (Smith, 1921), *C. jellesmae* (Boulenger, 1897), *C. khasiensis* (Jerdon, 1970), *C. laevigatus* Darevsky, 1964, *C. malayanus* (de Rooij, 1915), *C. marcuscombaii* (Darevsky, Helfenberger, Orlov and Shah, 1998), *C. martinstolli* (Darevsky, Helfenberger, Orlov and Shah, 1998), *C. matsui* Hikida, 1990, *C. nepalensis* (Schleich and Kästle, 1998), *C. papuensis* (Brongersma, 1934), *C. philippinicus* (Steindachner, 1867), *C. pseudoquadrivirgatus* Rösler, Nguyen, Vu, Ngo and Ziegler, 2008, *C. pubisulcus* Inger, 1958, *C. quadrivirgatus* Taylor, 1962, *C. semenanjungensis* Grismer and Le-

ong, 2005, *C. sermowaiensis* (de Rooij, 1915), *C. spinosus* Linkem, McGuire, Hayden, Setiadi, Bickford and Brown, 2008, *C. stresemanni* Rösler and Glaw, 2008, *C. sworderi* (Smith, 1925), *C. wakeorum* Bauer, 2003, *C. wallacei* Hayden, Brown, Gillespie, Setiadi, Linkem, Iskandar, Umilaela, Bickford, Riyanto, Mumpuni and McGuire, 2008 and *C. yoshi* Hikida, 1990. From *C. biordinis* Brown and McCoy, 1980 which possess two rows of femoral pores (vs. a single row in *C. tamaiensis*); from *C. darmandvillei* (Weber, 1890), *C. eisenmani* Ngo, 2008 and *C. grismeri* Ngo, 2008, which does not possess precloacal pores in males, and from those which possess a cloacal groove; *C. agamensis* (Bleeker, 1860), *C. gansi* Bauer, 2003, *C. marmoratus* (Kuhl, 1831), and *C. sadleiri* Wells and Wellington, 1985. From the following species which possess precloacal pores separated from femoral pore series by a diastema of non pore-bearing scales: *C. aequalis* Bauer, 2003, *C. agusanensis* (Taylor, 1915), *C. annandalei* Bauer, 2003, *C. brevipalmatus* (Smith, 1923), *C. capreoloides* Rösler, Richards and Günther, 2007, *C. gubernatoris* (Annandale, 1913), *C. wetariensis* (Dunn, 1927) and *C. ziegleri* Nazarov, Orlov, Nguyen and Ho, 2008.

From *C. fumosus* (Müller, 1895) by its larger adult size, SVL 90 mm (vs. 71–75 mm) and lower number of total lamellae on the 4th digit of the pes, 16 (vs. 20–22) and higher number of mid ventral scale rows in *C. lateralis* (Werner, 1896) (60–64) and *C. zugi* Oliver, Tjaturadi, Mumpuni, Kray and Richards, 2008 (45–52). From *C. batucolus* Grismer, Chan, Grismer, Wood and Belabut, 2008 by its larger adult size, SVL 90 mm (vs. 75.2 mm) and absence (vs. presence) of a distinct precloacal depression. From the following *C. tamaiensis* has a considerably higher or lower number of total 4th toe lamellae, 16: *C. buchardi* David, Teynie and Ohler, 2004 (12), *C. jarakensis* Grismer, Chan, Grismer, Wood and Belabut, 2008 (24), *C. louisiadensis* (de Vis, 1892) (27–31), *C. murua* Kraus and Allison, 2006 (24–25), *C. pantiensis* Grismer, Chan, Grismer, Wood and Belabut, 2008 (22–23), *C. papilionoides* Ulber and Grossmann, 1991 (10–14), *C. tuberculatus* (Lucas and Frost, 1900) (23–29). *C. novaeguineae* (Schlegel, 1837) possess tubercles on the throat, absent in *C. tamaiensis* and from the following it differs by having a considerably greater or lower number of longitudinal tubercle rows, 21: *C. serratus* Kraus, 2007 (10–11) and *C. seribuatensis* Youmans and Grismer, 2006 (27–35). *C. tiomanensis* Das and Lim, 2000 has a distinctly banded (vs. marbled) dorsal body pattern and greater number of total 4th toe lamellae, 20–22 (vs. 16): *C. ayeyarwadyensis* Bauer, 2003 differs from *C. tamaiensis* by its lower number of pores, 16–29 precloacal pores which only sometimes extend onto the femurs (vs. 40 precloacal-femoral pores) and absence (vs. presence) of enlarged femoral and precloacal scales. *C. derongo* Brown and Parker, 1973 and *C. loriae* (Boulenger, 1897) are considerably larger than *C. tamaiensis* at SVL 112 mm and 137 mm, respectively (vs. 90 mm) and further from the latter by possessing a greater number of 4th toe lamellae, 29–30 (vs. 16 in *C. tamaiensis*).

Cyrtodactylus tamaiensis was originally considered to only differ from *C. khasiensis* by possessing a distinctly greater number of pores, 40 precloacal-femoral pores (vs. 12–14 precloacal pores, not extending onto femurs). Such difference alone is clearly beyond intraspecific range. However, it also differs by its larger size, 90 mm (vs. 72.6–83.3 mm), fewer total 4th digit lamellae of the pes, 16 (vs. 19–24), relative digit lengths of the pes, 4 > 5 > 3 = 2 > 1 (vs. 4 > 5 > 3 > 2 > 1), and dorsal body pattern consisting of a dense and random marbling of pale and dark brown (vs. a more consistent series of longitudinal middorsal paired dark brown blotches with an additional dark dorsolateral row of blotches which may join to form a continuous stripe, on an otherwise pale brown background). From the recently described *C. khasiensis cayuensis*, it differs by possessing a greater number of pores, 40 precloacal-femoral pores (vs. 6–9 precloacal pores) and slightly higher number of midventral scale rows, 37 (vs. 28–34).

Cyrtodactylus mandalayensis sp. nov.

(Fig. 3)

Gymnodactylus khasiensis: M. A. Smith, 1935:53 (part).

Holotype.– BMNH 1900.9.20.1, immature? male, Mogok (17°34'0"N, 95°5'0"E, 1,170 m asl), on the River Ayeyarwadi, north-east of Mandalay, in the Pyin Oo Lwin District, Man-

dalay Division of northern Myanmar. Collected by H. Hampton, Esquire.

Condition.– The specimen is complete and undamaged with full original tail. It is slightly dehydrated. Specimen not tagged directly. The specimen is braced to a piece of card in Fig. 3A for the purpose of photograph as the body is fixed in a curved position otherwise preventing a single full dorsal photograph of the specimen. The card was removed after photography.

Etymology.– The specific epithet is an adjective referring to Mandalay, the political division in which the holotype was collected.

Distribution.– *Cyrtodactylus mandalayensis* sp. nov. is known only from the holotype collected from "Magok, on the Irawadi, northeast of Mandalay, Upper Burma". This locality is currently referable to Mogok (17°34'0"N, 95°5'0"E, 1,170 m asl), and is currently situated in Pyin Oo Lwin District, Mandalay Division of northern Myanmar.

Description of holotype.– This specimen is a male, appears to be immature, SVL 61.7 mm. Head moderately long (HL/SVL ratio 0.267), relatively wide (HW/HL ratio 0.679), somewhat depressed (HD/HL ratio 0.388), distinct from neck. Loreal and interorbital region weakly concave, canthus rostralis swollen but not well developed. Snout moderately short (OS/HL ratio 0.382); slightly longer than the orbit diameter (OD/OS ratio 0.905); scales on snout and head circular, granular, intermixed with small scattered tubercles posteriorly from the posterior edge of the orbits; scales on snout subequal in size to the anterior-most occipital tubercles. Orbits large (OD/HL ratio 0.345); pupil vertical with crenellated margins; supraciliaries moderately sized with bluntly pointed tips but no spines. Ear opening oval, vertically oriented, large (EL/HL ratio 0.079); orbit to ear distance slightly less than the orbit diameter (OD/OE ratio 1.188). Rostral 57.1% as deep (1.6 mm) as wide (2.8 mm), dorsally with midrostral suture approximately 50% rostral depth (Fig. 3B); two large supranasals separated by a single, smaller internasal; rostral in contact with first supralabials, nasals, supranasals, and internasal; nostrils vertically oval, laterally oriented, each in broad contact with rostral and also surrounded by supranasal, first supralabial, and three granular postnasals; 4–5 rows of scales separate orbit from supralabials. Mental triangular with a wide concave medial groove (possibly a result of dehydration), wider (2.5 mm) than deep (1.4 mm); one pair of greatly enlarged postmentals, each approximately 40% the size of the mental, left and right postmentals in broad medial contact without intervening granules, a longer contacting edge with each other than with the mental, each bordered laterally by the first infralabial and an enlarged lateral chin shield approximately 50% the size of the postmental, the pair bordered posteriorly by 3–4 small granules (Fig. 3C). Throat scales homogeneous small, rounded, granules. Enlarged supralabials to angle of jaws 12/10 (left/right); infralabials 10/9 (left/right), infralabials bordered by 1–3 rows of enlarged scales, largest anteriorly and laterally; 19 interorbital scales across the narrowest point of the frontal bone.

Body slender, relatively short (TrL/SVL ratio 0.417) with moderately developed ventrolateral folds, further emphasized with a row of rounded tubercles, subequal in size to those of the dorsum. Dorsal scales heterogeneous, primarily small rounded granules, intermixed with irregularly arranged medium sized (3–5 times granule size) circular tubercles, bluntly conical to weakly keeled both dorsally and laterally, tubercles extend from posterior to the frontal region to the base of the tail; tubercles on nape and occipital region considerably smaller than those of the dorsum and those of the tail are weakly keeled to bluntly conical; tubercles in 18 non linear longitudinal rows at midbody; 51 tubercles in a paravertebral row from the occiput to mid sacrum. Ventral scales much larger than dorsal, cycloid, imbricate to subimbricate; scales on throat minute, granular, grading into larger ventral scales posterior to the throat; 32 midbody ventral scale rows between ventrolateral folds. Enlarged femoral scales and femoral pores absent, a patch of slightly enlarged scales between the precloacal pores and vent; 5 small precloacal pores in a continuous, angular series with a further three pitted scales indicating that mature males may have at least 8 precloacal pores, an additional enlarged pore-bearing scale is situated immediately posterior to the angle of the continuous precloacal pore series, pore-bearing scales of this series are slightly enlarged relative to anteriorly contacting ventral scales;

no precloacal groove; hemipenal bulge distinct but appears underdeveloped in comparison with mature male specimens of other *Cyrtodactylus* species, the sunken appearance may also be a result of slight dehydration of the specimen.

Fore and hind limbs relatively slender; forearm (FAL/SVL ratio 0.143) and tibia (CL/SVL ratio 0.17) relatively short; digits relatively short, strongly inflected at each joint, all bearing robust, recurved claws; subdigital lamellae widened beneath basal phalanx; lamellae from first proximal scansor greater than twice the size of the largest palm scale to basal-most digital inflection: 4–4–5–5–4 (manus) and 5–5–6–6–5 (pes); lamellae from the basal-most digital inflection to the toe tip, not including the ventral claw sheath (intervening rows of nonlamellar granules between basal and distal lamellae series in parenthesis): 7(2)–9(1)–11(2)–7(3)–8(2) (manus) and 6(2)–8(3)–11(1)–12(1)–11(2) (pes); interdigital webbing is rudimentary on manus and pes. Relative length of digits (measurements in mm in parentheses): IV (4.8) > III (4.5) > II (4.2) > V (3.8) > I (2.7) (manus) and IV (7.2) > V (6.5) > III (6.2) > II (5.3) > I (3.2) (pes). Scales on the ventral manus and pes granular, smooth; scales on dorsal aspects of hind limbs granular, similar to dorsal scales, with enlarged conical tubercles interspersed. Dorsal scales of proximal forelimbs homogeneous, granular, slightly larger than dorsal body granules; scales of forearms heterogeneous sized granules without distinctly enlarged tubercles.

Complete original tail, subequal to body length (TTL/SVL 1.018), slender, vertically oval in cross section (TD/TW ratio 1.098). Scales not arranged in regular segments; mostly circular dorsally and oval to subquadrangular ventrally. Subcaudal scales larger than dorsals, gradually increasing in size laterally, i.e. 7 middorsal rows become 5 midventral rows; no transversely enlarged subcaudal plates. 4/3 (left/right) barely distinguishable postcloacal spurs consisting of slightly enlarged, smooth, rounded scales.

Colouration in preservative.– The dorsal surface of the head and snout primarily a pale yellowish brown with extensive brown mottling; dorsal body pattern consists of an approximately middorsal series of paired dark brown blotches, several are fused anteriorly to form single diagonal transverse blotches, forming a marbled pattern at mid trunk and posteriorly forming distinguished blotches, intervening areas are pale brown, light and dark markings not sharply defined (Fig. 3A), laterally appears mottled and faded with little distinction between light and dark pigments; fore and hind limbs mottled with varying shades from mid-brown to dark brown, no nuchal collar present; the posterior dark brown blotches which merge from the base of the tail to form wide dark and light transverse bands, a total of 10 light bands on the tail which are only slightly narrower than dark bands; ventral surface of the tail is mottled anteriorly, only the posterior third with complete bands. The entire ventral surface of the body, limbs, manus, pes, throat and chin plain pale yellowish brown. No information is available for the colouration in life.

Comparisons.– This species is diagnosable from all congenerics by the following combination of characters: SVL 61.7 mm; 5 precloacal pores in a continuous angular series with a single additional enlarged pored scale bordering posterior to the apex of the series angle; pore-bearing scales of the continuous series slightly enlarged relative to anteriorly adjacent ventrals; a distinct patch of slightly enlarged scales between the pore-bearing scales and cloaca; cloacal groove, enlarged femorals and enlarged transverse subcaudals absent; 3–4 post cloacal spurs; 32 midventral scale rows; 18 longitudinal, non-linear rows of enlarged tubercles middorsally; 18 complete lamellae under the 4th digit of the pes and dorsal body pattern consisting of irregular dark brown blotches on a pale brown background.

Cyrtodactylus mandalayensis sp. nov. can be distinguished by the absence of enlarged subcaudal plates from *C. aaroni*, *C. aurensis*, *C. badenensis*, *C. baluensis*, *C. caovansungi*, *C. chanhomeae*, *C. chauquangensis*, *C. condorensis*, *C. consobrinoides*, *C. consubrinus*, *C. cracens*, *C. deveti*, *C. edwardtaylori*, *C. epiroticus*, *C. feae*, *C. fraenatus*, *C. hontreensis*, *C. huynhi*, *C. ingeri*, *C. interdigitalis*, *C. jarujini*, *C. klugei*, C. *macrotuberculatus*, *C. malcomsmithi*, *C. mimikanus*, *C. nigriocularis*, *C. oldhami*, *C. paradoxus*, *C. peguensis*, *C. phongnhakebangensis*, *C. pulchellus*, *C. ramboda*, *C. redimiculis*, *C. robustus*, C. *rubidus*, *C. russelli*, *C. slowinskii*, *C. soba*, *C. solomonensis*, *C. subsolanus*,

Table 1. Mensural and meristic values for the holotype of *C. tamaiensis* and *C. mandalayensis* sp. nov. All measurements in millimeters, abbreviations as per the Materials and Methods section.

	C. tamaiensis	*C. mandalayensis*
	BMNH 1946.823.22	BMNH 1900.9.20.1
	male	male
SVL	90.0	61.7
TTL	103.0	62.8
RTL	0	0
TW	7.6	4.1
TD	6.4	4.5
TrL	36.9	25.7
HL	23.6	16.5
HW	16.8	11.2
HD	9.2	6.4
JW	13.7	10.4
OD	7.2	5.7
IO	7.8	4.7
OS	9.3	6.3
EL	1.7	1.3
OE	7.5	4.8
IN	3.4	2.1
FAL	11.8	8.8
CL	15.8	10.5

C. sumonthai, *C. takouensis*, *C. thirakhupti*, *C. tigroides*, *C. tripartitus* and *C. variegatus*. From the following species which possess enlarged femoral scales and/or femoral pores in males; *C. aequalis*, *C. agusanensis*, *C. annandalei*, *C. biordinis*, *C. brevipalmatus*, *C. capreoloides*, *C. darmandvillei*, *C. fumosus*, *C. gubernatoris*, *C. irregularis*, *C. loriae*, *C. louisiadensis*, *C. marmoratus*, *C. nepalensis*, *C. novaeguineae*, *C. sadleiri*, *C. seribuatensis*, *C. serratus*, *C. spinosus*, *C. tamaiensis*, *C. tiomanensis*, *C. tuberculatus*, *C. wetariensis*, *C. ziegleri* and *C. zugi*.

The following species do not possess precloacal pores in males: *C. eisenmani*, *C. gordongekkoi*, *C. grismeri*, *C. jellesmae*, *C. laevigatus*, *C. semenanjungensis*, *C. sermowaiensis* and from those which possess a cloacal groove; *C. agamensis*, *C. cavernicolus*, *C. gansi*, *C. papuensis*, *C. philippinicus*, *C. pubisulcus*, *C. stresemanni* and *C. wallacei*. *Cyrtodactylus mandalayensis* sp. nov. can be distinguished from the following by possessing 32 midventral scale rows; *C. adleri* (48–50), *C. annulatus* (50–60), *C. brevidactylus* (45), *C. cryptus* (47–50), *C. derongo* (46–48), *C. intermedius* (40–50), *C. lateralis* (60–64), *C. malayanus* (58–62), *C. matsui* (51), *C. pseudoquadrivirgatus* (41–57), *C. sworderi* (42–48) and *C. yoshii* (50–58), a considerably higher or lower number of total 4th toe lamellae, 18; *C. angularis* (9–13), *C. buchardi* (12), *C. irianjayaensis* (28–35), *C. murua* (24–25), and from *C. ayeyarwadyensis*, *C. khasiensis*, *C. jarakensis* and *C. pantiensis* which do not possess enlarged scales between the precloacal pores and cloaca. It differs from *C. elok* and *C. papilionoides* by having a greater number of longitudinal tubercle rows, 18 (vs. 5–10 and 12–14, respectively); from *C. quadrivirgatus* by possessing a higher number of precloacal pores in a continuous series, 5 (vs. 0–4) and a blotched (vs. striped) body pattern, and from *C. batucolus* which has 43–46 precloacal-femoral pores. *Cyrtodactylus mandalayensis* sp. nov. differs from *C. wakeorum* by presence (vs. absence) of moderately developed ventrolateral folds and dorsal pattern of blotches (vs. thin transverse bands), from *C. markuscombaii* by absence (vs. presence) of wide transverse dorsal bands and small chin shields bordering the first postmentals posteriorly. Further from *C. markuscombaii* and *C. martinstolli* by presence (vs. absence) of an enlarged pored scale posteriorly bordering the angular pored series.

Cyrtodactylus mandalayensis sp. nov. shares only with *C. chrysopylos* the single enlarged median pore-bearing precloacal scale positioned posterior to the continuous angular series of precloacal pores. Although both species are known only from a single specimen the new species described here differs sufficiently in characters to be considered unique. It can be distinguished from *C. chrysopylos* by enlarged median pore-bearing scale only slightly larger than pored scales of the continuous series to which it is directly in contact (vs. enlarged median pored scale considerably larger than pore-bearing scales of the continuous series and separated from the series by a single enlarged scale); five precloacal pore-bearing scales (vs. 10 precloacal pore-bearing scales); relative toe lengths 4 > 5 > 3 > 2 > 1 (vs. 4 > 3 > 5 > 2 > 1); relative finger lengths 4 > 3 > 2 > 5 > 1 (vs. 4 > 3 > 5 > 2 > 1); dorsal pattern consists of irregularly arranged dark blotches on a primarily

pale background; and nuchal band absent (vs. primarily wide dark transverse bands separated by narrow light bands, prominent dark nuchal band present).

Cyrtodactylus khasiensis has been reported by Smith (1935, 1940) as occurring in Myanmar based entirely on the two specimens discussed here. There appears to be no further collections of the species from this country, thus with the elevation of *C. khasiensis tamaiensis* to the rank of species, and description of the only other known Myanmar "*C. khasiensis*" specimen (Smith, 1935) as a new taxon, *C. khasiensis* should be excluded from the species list of Myanmar, which now comprises 17 species of *Cyrtodactylus*.

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APPENDIX I

Comparative material examined

Cyrtodactylus gubernatoris: Holotype ZSI 17275 male, Darjeeling, West Bengal, India.

Cyrtodactylus khasiensis: BMNH 1906.8.10.4 (former ZSI 6198) female, "Khasi Hills", BMNH (18)74.4.17.134 female, "northeast Bengal", ZSI 5828 female and ZSI 5831–5832 males, Cherrapunji, Khasi Hills, Meghalaya, India.

Cyrtodactylus "khasiensis": BMNH (18)90.11.10.205 female, "Assam Hills", ZSI 16896 male, "Kobo, Abor Hills, 400ft, Assam", ZSI 21040 female, Bank of Monai River, ~1 km e. of Batail Kunda, Arunachal Pradesh, ZSI 24843 female, Seppa, East Kamang Dist., Arunachal Pradesh, ZSI 19546 female, Darjeeling, Gopaldhara, West Bengal.

Cyrtodactylus sp.: JUHG 0010, 0059–0061, 125–127, Kaptai, Rangamati District, Chittagong Division, Bangladesh, JUHG 0161, 0162, 0195–0197, Milonchari, Bandarban District, Chittagong Division, Bangladesh.

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On the occurrence of *Amphiesma khasiense* (Serpentes: Natricidae) in Thailand

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(with four text-figures)

ABSTRACT.– **We update the knowledge on the distribution of the rare mountain stream dweller snake *Amphiesma khasiense* in Thailand, including the first records from Northern Thailand, in Chiang Mai and Chiang Rai provinces. Morphological data are provided for these specimens. Our biological observations confirm the species' riparian and nocturnal habits.**

KEY WORDS.– **Natricidae, *Amphiesma khasiense*, Chiang Mai, Chiang Rai, riparian habitat, Thailand.**

Introduction

Originally described from the Khasi Hills in north-eastern India, *Amphiesma khasiense* (Boulenger, 1890) was subsequently found in northern Myanmar, south-western China (Yunnan and Xizang provinces; Zhao and Adler, 1993: 226) and northern Laos (Xiengkhuang and Phongsaly provinces; examined specimens). More recently, this species was discovered in north-eastern Thailand, where so far, a single specimen from Phu Luang, Loei Province, was recorded (Chanhome et al., 2001). It is a rarely encountered and poorly known snake, associated with mountain stream environments. Its discovery in two localities in northern Thailand leads us to give an update on the knowledge of its distribution and morphological variation in the country.

Materials and methods

The identifications are based on external morphological and colouration characters. Body measurements were made to the nearest millimeter. Paired meristic characters are given in the left/right order. Ventral scales were counted following Dowling's (1951) method, and are preceded by the number of preventrals (scales anterior to the ventrals, wider than long, but not in contact on each side with the first dorsal scale row). The terminal tail scute is not included in the subcaudal count. Sex was determined by dissection of the base of the tail.

Abbreviations: Morphological characters: AN: anal scale; D: divided; DSR: dorsal scale rows, counted, respectively, at one head length behind head, at midbody (above the ventral corresponding to half of the total number of ven-

trals), and at one head length before vent; Lor: loreal scale; SC: subcaudal scales; SRR: scale row reduction; SVL: snout-vent length; TaL: tail length; TL: total length; VEN: ventral scales. Institutions: BMNH: British Museum of Natural History, London; CTNRC: Center for Thai National Reference Collections, Bangkok; KZM: Korat Zoo Museum, Korat; MNHN: Muséum National d'Histoire Naturelle, Paris; QSMI: Queen Saovabha Memorial Institute, Thai Red Cross, Bangkok.

Results

In April 2008, one of us (KK) collected two adult *Amphiesma khasiense* (see Fig. 1–2), QSMI 542 and KZM 001, near Ban Pa Miang Mae Hang (X: 534000, Y: 2124300, UTM Zone 47), Moo. 7, Tambon (= Subdistrict) Pagnew, Wieng Pa Pao District, Chiang Rai Province, northern Thailand. The locality is situated at ca. 1,200 m asl. They were actively foraging at 0200 h on leaf litter, along a fast-flowing stream in a secondary forest. They were slow to escape and did not make any attempt to bite when handled. Their main meristic characters are presented in Table 1.

QSMI 542 has a SVL of 339 mm, a TaL of 170 mm (thus, a TL of 509 mm), 1+2 / 1+2 temporals, and has a SRR resulting from the fusion of rows 3 and 4 into row 3 at the level of ventral number 101 on both sides. KZM 001 has a SVL of 311 mm, a TaL of 142 mm (TL of 453 mm), and shows 1+1+2 / 1+2 temporals, and a SRR through fusion of rows 3 and 4 into 3 at the level of ventrals 95 and 96 respectively. Both have keeled dorsal scales, apart from the first row except posteriorly, where there is a weak keel. They also share 2/2 internasals, 2/2 prefrontals and 1/1 Lor. Their dorsum ground colour is dark brown, with a lighter stripe on row 5, with the stripe comprising whitish spots at 1–3 scale lengths from each other, becoming indistinct posteriorly. Their ventral colour is white, except that the lateral parts of the ventrals are of the same colour as the dorsum. The infralabials are white, each with a small black spot; the throat is white. The tail underside is white anteriorly, darkening towards the tail tip. The pupil is round and black, the iris is dark red. Each supralabials have a large white spot surrounded by black colour.

On 18 May 2008, one of us (SW) encountered a single, adult specimen (Fig. 3) in Doi Inthanon National Park, Chiang Mai Province, northern Thailand. The exact coordinates of the locality are X: 449319, Y: 2050066 (UTM Zone 47); the altitude was ca. 1,300 m asl. This individual was actively foraging at 2030 h, immediately after a rain shower, along a man-made pool where *Tylototriton verrucosus* Anderson, 1871 (Urodela: Salamandridae) were also observed. Along the pool, which is surrounded by agricultural fields, *Polypedates leucomystax* (Gravenhorst, 1829) and *Rhacophorus bipunctatus* Ahl, 1927 (Rhacophoridae) were also found. The snake was gentle and did not try to bite when handled. Figure 3 shows its typical lateral head and body patterns, as well as several meristic characters (a.o., 10 SL, whose 4–6 in contact with the eye, 1 Lor, 1 PreO, 3 PoO, 1 anterior temporal).

Besides this latter specimen, we examined another one from Doi Inthanon National Park, CTNRC 980504. It has a SVL of 352 mm, a TaL of 183 mm (TL 535 mm), 1+2 / 1+2 temporals,

Table 1. Main meristic characters of Thai and syntypical *Amphiesma khasiense*.

Collection number	Sex	DSR	VEN	AN	SC	SL	IL	PreO	PoO
CTNRC 980504	M	19–19–17	1+142	D	107, D	9(4–6) / 9(4–6)	10(5) / 10(5)	1/1	3/3
QSMI 273	F	19–19–17	0+143	D	97, D	9(4–6) / 9(4–6)	10(5) / 10(5)	1/1	3/3
QSMI 542	F	19–19–17	2+145	D	99, D	9(4–6) / 9(4–6)	10(5) / 10(5)	1/1	3/3
KZM 001	F	19–19–17	2+145	D	89, D	10(4–6) / 9(4–6)	10(5) / 10(5)	1/1	3/2
BMNH 1946.1.12.80	F	19–19–17	2+148	D	95, D	9(4–6) / 9(4–6)	10(5) / 10(5)	1/1	3/3
BMNH 1946.1.12.81	M	19–19–17	2+148	D	> 48	9(4–6) / 8(3–5)	10(5) / 11(5)	2/1	3/3
BMNH 1946.1.12.82	M	19–19–17	2+150	D	> 79	9(4–6) / 9(4–6)	10(5) / 11(5)	1/1	3/3
BMNH 1946.1.13.45	F	19–19–17	1+152	D	99, D	9(4–6) / 9(4–6)	10(5) / 10(5)	1/1	3/3

(*plus an additional half ventral on the right side just before the anal scale)

Figure 1. Detail of the head of an adult *Amphiesma khasiense* from near Ban Pa Miang Mae Hang, Chiang Rai Province, Thailand. Photo: K. Kunya.

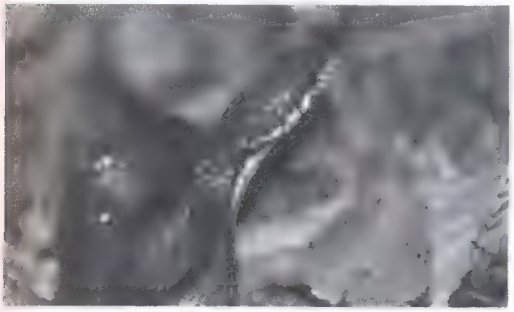

Figure 2. Adult *Amphiesma khasiense* from near Ban Pa Miang Mae Hang, Chiang Rai Province, Thailand. Photo: K. Kunya.

and a SRR through fusion of rows 3 and 4 into 3 at the level of ventrals 91 and 96, respectively. Other main characters are shown in Table 1. All dorsal scale rows are keeled, with the first row having only a weak keel. It is the only confirmed male known so far from Thailand.

Discussion

The colour and meristic data of the newly collected Thai *Amphiesma khasiense* concur with those of the syntypes of the species (see Table 1 and Boulenger, 1890:344) and with the single previously known Thai specimen, from Phu Luang in north-eastern Thailand (QSMI 273, see Table 1 and Chanhome et al., 2001). The use of the identification key to Indochinese *Amphiesma* provided by David et al. (2007) also leads to *A. khasiense*. The key indicates a keeled first dorsal row in *A. khasiense*; this keel is actually weak or not visible anteriorly in the Thai specimens. The keeling seems in fact related to age, the longest specimens being more strongly keeled, especially posteriorly.

Amphiesma khasiense was largely confused in the literature with *A. modestum*, *A. boulengeri* and *A. inas*. An adult *Amphiesma* specimen illustrated by Chan-ard et al. (1999:153) from a primary forest at 950 m asl on Phu Luang was erroneously identified as *A. inas*. However, if the dorsal colouration and pattern of this specimen are similar with those of *A. khasiense*, the colour pattern of its supralabials are much closer to those of specimens occurring in Vietnam and Cambodia. In these eastern populations, the white, round blotches in the middle of the supralabials are replaced by elongate streaks or even a continuous stripe. We examined 6 (3 ♂, 3 ♀) specimens from Cardamom Mountains (Cambodia), referred to *Amphiesma* cf. *khasiense* by Grismer et al. (2007). In all of them, the labial pattern comprises elongate streaks, more or less contigous. The same was observed in about 75 specimens from Vietnam. In contrast, one specimen from Phongsaly Province, North Laos (MNHN 2004.0248), shows the typical pattern observed in *A. khasiense* specimens from India, Myanmar and northern Thailand. A revision of this group is in progress. There might be two species under the specific nomen *khasiense* in the Indochinese Peninsula. Pending the results of this revision, and in agreement with our statement in Chanhome et al. (2001), this specimen from Phu Luang is best identified as *Amphiesma* cf. *khasiense*, inasmuch we confirmed above the occurrence of the genuine *A. khasiense* on the basis of a preserved specimen.

Figure 3. Adult *Amphiesma khasiense* from Doi Inthanon National Park, Chiang Mai Province, Thailand. Photo: S. Waengsothorn.

Nabhitabhata (1987) listed, without comments nor voucher material, *Amphiesma modestum* from Doi Suthep-Pui National Park, Chiang Mai Province, northern Thailand. That record might refer to *Amphiesma khasiense*, or even more likely, to *A. deschauenseei*. This taxon is related to *A. modestum*, although quite dis-

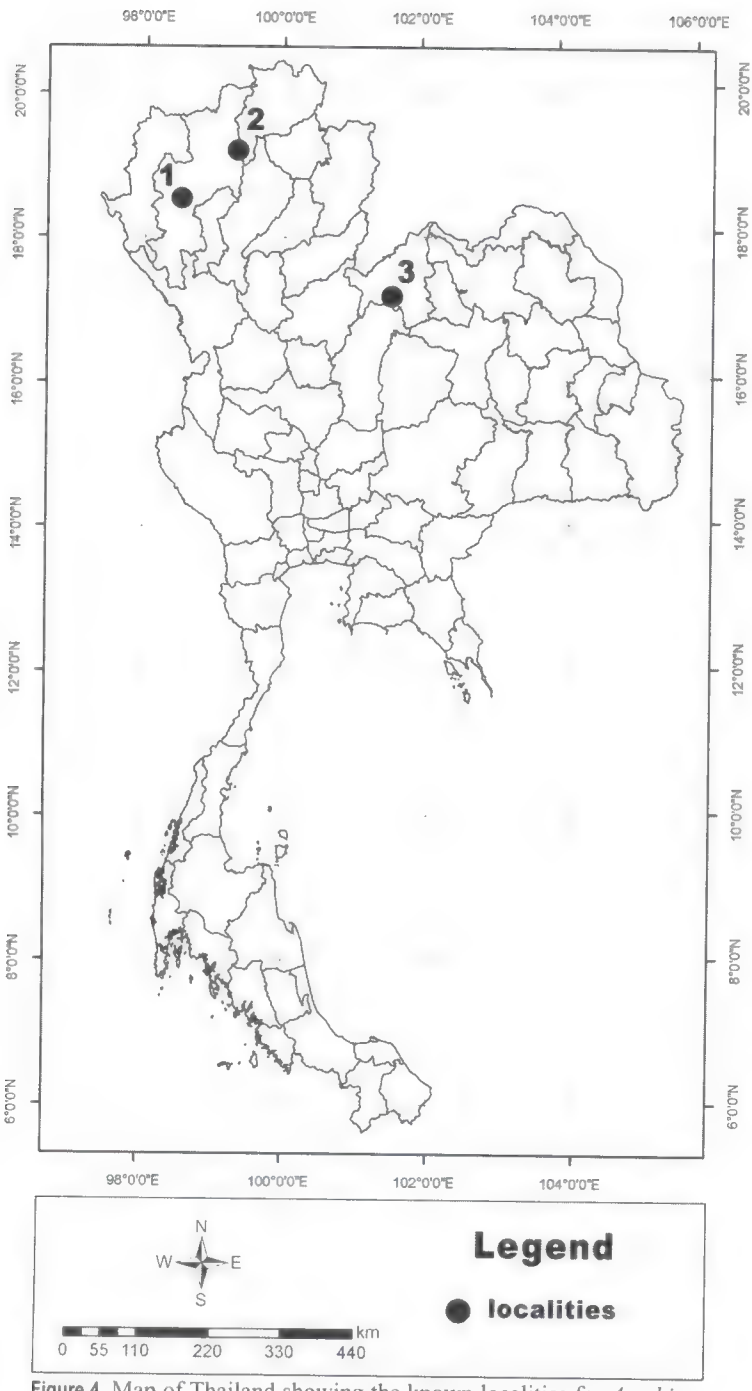

Figure 4. Map of Thailand showing the known localities for *Amphiesma khasiense* in Thailand. 1 = Doi Inthanon National Park, Chiang Mai Prov.; 2 = Ban Pa Miang Mae Hang, Chiang Rai Prov.; 3 = Phu Luang, Loei Prov. Map by S. Waengsothorn.

tinct from *A. khasiense* and cannot be excluded, since it is also known from Chiang Mai Province. Diagnostic differences between *Amphiesma khasiense*, *A. boulengeri* and *A. inas* were presented in Chanhome et al. (2001) and David et al. (2007). *Amphiesma boulengeri* has never been recorded from Thailand and *A. modestum* has been cited but not vouchered (unless one considers *A. deschauenseei* to be a synonym of *A. modestum*, a position accepted by Smith [1943] but we refute this on the basis of our unpublished data), and *A. inas* is so far confirmed only from southern peninsular Thailand.

The current confirmed data on the distribution of *Amphiesma khasiense* in Thailand (see Fig. 4), i.e., its presence above 900 m asl in three parallel mountain ranges, from West to East, Thanon Thongchai Range (Doi Inthanon), Khun Tan Range (Ban Pa Miang Mae Hang) and Phetchabun Range (Phu Luang), seems to indicate a penetration southwards through high elevation stations. According to this zoogeographical pattern, the occurrence of this species can be expected in Phi Phan Nam Range and Louang Prabang Range, parallel to and between Thanon Thongchai Range and Phetchabun Range. The status of the numerous specimens of "*A. khasiense*" recorded from northern Vietnam is under revision. Along Thanon Thongchai Range, the species might even be expected as far south as Kanchanaburi Province. The above data reveal the capacity of

the species to inhabit degraded environments. Its conservation does not seem to currently represent an issue, being known from two national parks- Phu Luang and Doi Inthanon.

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A catalogue of amphibians and reptiles in the collection of Jahangirnagar University, Dhaka, Bangladesh

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ABSTRACT.- **We present here details of a collection of herpetofauna from Bangladesh, held at the Jahangirnagar University Herpetological Group, Dhaka. This collection is comprised of at least 58 species, six are tentatively identified to their nearest described species which themselves are recognised to consist of more than one cryptic species. Four species could not be accurately identified to species level. It is likely that some of these ten "species" represent cryptic species and possibly undescribed taxa. Several of the localities presented here provide the first confirmed localities for species previously listed as present in Bangladesh, but were not confirmed with locality or specimen data. Other species in the collection represent previously unknown localities, e.g., *Euphlyctis hexadactylus*, *Uperodon globulosus* and *Cyrtodactylus* sp. *Eutropis multifasciata*, and *Hylarana* cf. *nigrovittata*, are here recorded from Bangladesh for the first time based on our collections and *Takydromus khasiensis* is also reported for the first time from Bangladesh based on apparently unpublished specimens in the collection of the California Academy of Science.**

KEY WORDS.- **Reptiles, Amphibians, Bangladesh, Jahangirnagar University, new country records.**

INTRODUCTION

The herpetofauna of Bangladesh is poorly known compared to the neighbouring countries, such as India and Myanmar. Various checklists (Khan, 1986; Choudhury, 1996; Ahsan, 1998; IUCN, 2000; Asmat et al., 2003; Khan, 2004) have been published in the past listing up to 163 extant species (Ahsan, 1998), there are very few recently confirmed localities or available specimens in museum collections for many of the species that are reported as present. Collections made prior to 1947 form the basis for the majority of our current knowledge on the distributions of herpetofauna, however the locality data for many of these specimens were given as from "Bengal" with no further details. Bengal is now split into West Bengal (India) and Bangladesh, thus for several species, it is difficult, or sometimes impossible to determine from which country the specimens were originally collected. Adding to this problem is that Bangladesh of the pre-1950's was a different place, compared to the current Bangladesh, whereby the once large expanses of natural habitat that would have harboured those species of historic collections are reduced to a few relatively small fragments of anthropogenically disturbed habitats. Bangladesh currently has no scientifically maintained natural history museum or other recognised national repository for biological specimens, further adding difficulty when trying to confirm the presence or absence of presumed extant species.

In recent years, there has been a revival of interest in the herpetofauna of Bangladesh, with

several publications emerging, such as those of Khan (1997, 2001), Khan (2007), Hasan et al. (2007), Mahony and Ali Reza (2007a–d), Ali Reza and Mahony (2007), Ali Reza (2007, 2008a–b) and Kabir et al. (2008). Some of these publications, however, contain errors such as misidentifications of species or overlooked historic literature records, some of which will be addressed in the discussion.

Jahangirnagar University was established in 1970, making it one of the oldest public universities in Bangladesh. In the past, members of the Zoology Department sporadically collected herpetofaunal specimens primarily while carrying out research on other faunal groups or regional fauna in general. Since 2007, with the formation of the Jahangirnagar University Herpetological Group (JUHG), more focused and intensive collections have been made at several localities in Bangladesh. A greater emphasis is now put on the documentation and cataloguing of specimens with the aim to provide a well maintained national repository for herpetofaunal collections. To achieve this goal, the authors have collaborated on this effort to catalogue all specimens currently within the collection to aid in a better understanding of the country's extant herpetofauna.

Materials and methods

All specimens prior to 2007 were collected from localities, primarily by authors 2, 3 and 4, while carrying out research projects on other faunal groups. At that time, some collection dates and GPS coordinates of collection sites were not recorded, thus the dates provided here are restricted to the month and year when known with certainty and when the month is in doubt, it is not included. For specimens included here which were not collected by the authors, these collectors are listed in the acknowledgements. Specimens previously discussed in Mahony and Ali Reza (2007a–d), Ali Reza and Mahony (2007) and Ali Reza (2007) are not included in this paper. In 2007 specific herpetofaunal surveys were carried out at the following localities (attending authors in brackets); at Rangamati District (1–5), Bandarban District (1 & 4), Coxes Bazar District (1, 2 & 4) and Dhaka District (1–4). Most specimens collected were euthanized within 24 hours of collection, with the exception of several snakes which were kept alive in captivity for up to three weeks for captive feeding/behavioural observations and education purposes. After euthanasia, specimens were fixed in 4% formalin for between 12 hours and 3 days (while in the field) and later stored in either 4% formalin or 70% EtOH. Specimen numbers followed by "(D)" refer to dry (skinned and stuffed) specimens. All specimens are stored at the JUHG laboratory, Zoology Department, Jahangirnagar University. Four locality records are included here that are not represented by specimens at the JUHG, but are photo-vouchers deposited at the Zoological Reference Collection (collection of images), Raffles Museum of Biodiversity Research ZRC(IMG). G.P.S. coordinates and altitude were primarily taken with a Garmin GPS 48 and Explorist. Abbreviations used in locality information are National Park (N.P.), Wildlife Sanctuary (W.S.), Forest Office (F.O.), Forest Department Training Center (F.D.T.C), Range Office (R.O.), Hillside Resort (H.R.), Jahangirnagar University campus (J.U.), Bangladesh Livestock Research Institute (B.L.R.I.), and for species collected from elevated positions, metres above ground level (m a.g.l.).

Specimens were identified by comparison with museum collections at the Zoological Survey of India, Kolkata (ZSI), the Natural History Museum, London (BMNH) and Arya Vidyapeeth College, Assam (AVC), or with the aid of the following literature; Bossuyt and Dubois (2001), Boulenger (1882), Dubois (1975), Dutta and Manamendra-Arachchi (1996), Matsui et al. (1986, 1999), McGuire and Kiew (2001), Rösler (2001), Schleich and Kästle (2002), Smith (1935, 1943), Whitaker and Captain (2004) and Zug et al. (2006, 2007). Nomenclature for Amphibia follows Frost et al. (2006), except where modified by Che et al. (2007) regarding Hylarana and Stuart (2008) regarding Clinotarsus, and for Reptilia, Uetz, 2007 (accessed 30 April 2008) is followed. Species proven by other authors to represent currently unresolved species complexes, or require further research for a definitive identification, are referred to here as "cf." pending comparisons with appropriate type material.

Results

Bufonidae

Duttaphrynus melanostictus (Schneider, 1799)

CHITTAGONG DIVISION, Rangamati District, Kaptai Village: JUHG 0118–0119 adults (22°30'N, 92°12'E), collected at night, under a light at the F.D.T.C. rest house, 1–2 September 2007.

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0260 adult (23°52'N, 90°16'E), collected from a student's dorm at night under a light, 2002, ~1930 h.

Ranidae

Clinotarsus alticola (Boulenger, 1882)

SYLHET DIVISION, Maulvibazar District, Sreemangal, Lawachara N.P.: JUHG 0016 metamorph (24°19'N, 91°47'E), from a bank next to stagnant water, 9 October 2006, 1920 h.

CHITTAGONG DIVISION, Rangamati District, Kaptai Village: JUHG 0110 adult (22°30'N, 92°12'E), 1 September 2007.

Remarks.– Metamorph specimens of many ranids can be notoriously difficult to identify accurately when relying on morphological data alone. This individual retains the characteristic ocelli on the base of its tail.

Hylarana leptoglossa (Cope, 1868)

CHITTAGONG DIVISION, Rangamati District, Kaptai Village: JUHG 0107–0109 adults (22°30'N, 92°12'E), 1–2 September 2007.

DHAKA DIVISION, Tangail District, Rasulpur, Madhupur N.P.: JUHG 0012 adult (24°41'N, 90°08'E), collected from long grass, 7 December 2007, 2030 h.

BARISAL DIVISION, Barisal District, Ujirpur: JUHG 0018 male (22°49'N, 90°15'E), collected from amongst leaves near a stagnant pool, 6 April 2007, 1020 h.

Remarks.– This species has been previously recorded from Mymensingh District (Romer, 1949, Mahony and Ali Reza, 2007c) and from the Chittagong Division, but without specific locality data (Asmat et al., 2003).

Hylarana cf. *nigrovittata* (Blyth, 1856)

CHITTAGONG DIVISION, Rangamati District, Kaptai: JUHG 0006 and 0104 females (22°28'N, 92°13'E), Kaptaimukh Beat, one found in a tree hole at 0.6 m a.g.l., 8–10 m from Karnaphuli River (naturally slow moving river), the second collected at night from grass, near a stagnant water body, 3 September 2007 and 18 October 2007, 1710 h. JUHG 0071 female (22°30'N, 92°12'E), at the edge of Kaptai Village on a trail in a small disturbed patch of semi-evergreen forest near a narrow slow moving stream, 19 October 2007, 1900 h.

Bandarban District, Bandarban, Milonchari: JUHG 0174–0176 males, 0191, 0192 females (22°10'N, 92°13'E, 150 m asl) near H.R. at the edge of a pool of a small slow moving roadside stream next to a bushy area of natural vegetation, 13–16 November 2007, 1830–2100 h.

Remarks.– This species is a member of the problematic *Hylarana nigrovittata* complex. The specific identity of this species will be discussed elsewhere.

Hylarana tytleri (Theobald, 1868)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0007, 0019–0020, 0241 (23°52'N, 90°16'E), collected from a patch of Sun grass (grows to a height of ca. 1.5 m) near a lake, July 2005, 1130 h.

Remarks.– This species was originally described based on specimens collected from "Dacca" (= Dhaka, Bangladesh) (Theobald, 1868). The holotype currently in the collection of ZSI is greatly decomposed (Ohler and Mallick, 2002), thus this topotypic material provides an important addition to the JUHG collection. Not clearly addressed by Ohler and Mallick (2002) but perhaps worth mentioning here is the taxonomic placement of the name *Rana bilineata* (Pillai and Chanda, 1981), provided the nomen novum *Rana albolineata* by Dubois (1987) and later referred to the synonymy of *Rana taipehensis* by Dubois (1992). Ohler and Mallick (2002) list the specimens described by (Pillai and Chanda, 1981) to represent *Rana tytleri,* therefore, removing *Rana bilineata* (Pillai and Chanda, 1981) and *Rana albolineata* (Dubois, 1987) from the synonymy of *H. taipehensis*, to become junior subjective synonyms of *Hylarana tytleri* (Theobald, 1868).

Dicroglossidae

Euphlyctis cyanophlyctis (Schneider, 1799)

CHITTAGONG DIVISION, Cox's Bazar District, Chokoria, Malumghat: JUHG 0043, 0090–0092, near Faishakhali R.O. in a mature Teak, Jam and *Acacia* plantation in a temporary rainwater puddle, 21 October 2007, 1100 h and 1900 h.

Bandarban District, Bandarban, Milonchari: JUHG 0149 female (22°10'N, 92°13'E) from within a concrete reservoir at the edge of the H.R, 11 November 2007, 1930 h.

DHAKA DIVISION, Dhaka District, Savar, B.L.R.I.: JUHG 0226 female, collected from a road side ditch, 6 October 2007.

Euphlyctis hexadactylus (Lesson, 1834)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0005 adult (23°52'N, 90°16'E), collected from a lake within the Wildlife Rescue Center, 5 October 2006.

KHULNA DIVISION, Bagherhat District, Sundarban N.P.: JUHG 0244 adult, 1996.

Remarks.– Khan (2004) provided a single Bangladesh locality from the Sundarbans. The authors could find no further documentation of this species from elsewhere in Bangladesh thus this record from the Dhaka Division would represent an eastern range extension for the species in Bangladesh.

Fejervarya sp.

CHITTAGONG DIVISION, Rangamati District, Kaptai: JUHG 0035–0036, 0075–0076, 0080–0081, 0102–0103 (22°28'N, 92°13'E), Kaptaimukh Beat, mostly collected from within 2 m from a small slow moving stream in a cleared forested habitat, with bushy secondary growth, 3 September 2007 and 18 October 2007, ~1930 h. JUHG 0082–0084, 0094–0100 (22°30'N, 92°12'E), mostly collected from the lawn of the F.D.T.C. Officers Hall on the outskirts of Kaptai Village, 1–2 September 2007 and 17 October 2007, 1800–2300 h.

Cox's Bazar District, Chokoria, Malumghat: JUHG 0022, 0045–0049, 0087–0089, collected at and near Faishakhali R.O. within a small mature Jarul and Jam plantation, 20 October 2007, 1530–1900 h.

Bandarban District, Bandarban, Milonchari: JUHG 0145–0148, 0150–0151, 0178, 0188 (22°10'N, 92°13'E), all collected from two localities, two specimens were collected from a grassy area within the H.R., 11 and 14 November 2007, 1930 h and 1030 h., the remaining specimens were collected from the bank of a stream in the Sangu River valley below the H.R., 16 November 2007, 1200 h.

DHAKA DIVISION, Tangail District, Rasulpur, Madhupur N.P.: JUHG 0213 (24°41'N, 90°08'E), on the deciduous forest floor, amongst leaf litter and grasses, 7 December 2007.

Dhaka District, Savar, B.L.R.I.: JUHG 0225 male, collected from a grassy roadside verge, October 2007.

Remarks.– This collection of *Fejervarya* includes specimens of two or possibly three cryptic species. An attempt to identify these specimens could not be confidently made as bioacoustic data could not be obtained outside of the breeding season. Furthermore, the collection contains insufficient numbers of adult specimens from each locality, to attempt to accurately compare these populations morphometrically using principal component analysis.

Hoplobatrachus tigerinus (Daudin, 1803)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0259 adult (23°52'N, 90°16'E), 1994.

CHITTAGONG DIVISION, Cox's Bazar District, Chokoria, Dulahazara: JUHG 0137 adult, collected from the bank of a pond next to Dulahazara Safari Park Forestry Guest House, 20 October 2007, ~2100 h.

Occidozyga cf. *borealis* (Annandale, 1912)

CHITTAGONG DIVISION, Rangamati District, Kaptai: JUHG 0072–0074 (22°30'N, 92°12'E), from the bank of a small slow moving portion of a stream within a patch of disturbed semi-evergreen forest at the edge of Kaptai Village, 19 October 2007, 1200 h and 1900 h.

Bandarban District, Bandarban, Milonchari: JUHG 0154–0155, 0160, 0179, 0181–0186, 0189–0190 (22°10'N, 92°13'E) from the edges of a narrow, rocky cascading stream at the outer edge of the H.R. This stream is bordered by a narrow strip of natural semi-evergreen forest vegetation surrounded by jhum cultivation. One

specimen was collected amongst long grass bordering the strip of natural vegetation; all others were collected from banks of streams, 13–15 November 2007, 1030–1930 h.

Remarks.– This species is morphologically similar to *Occidozyga borealis* which is suspected to consist of a complex of cryptic species. Further, comparative material will be examined before confirming its identification. Previously *O. borealis* has been reported from the Rangamati hilly area by Asmat (2005) and later by Ali Reza (2008a) from Bandarban District.

Microhylidae

Kaloula pulchra (Gray, 1831).

SYLHET DIVISION, Maulvibazar District, Sreemangal, Lawachara N.P.: JUHG 0013, 0227–0228 adults (24°19'N, 91°47'E), 6 October 2004.

Hobiganj District, Chunarughat, Rema Kalenga W.S.: JUHG 0243 adult, from amongst aquatic grasses in a temporary stagnant water body within the forest, 11 May 2007.

CHITTAGONG DIVISION, Cox's Bazar District, Chokoria, Malumghat: JUHG 0073 subadult, collected at Faishakhali R.O., where it was emerging from a wood pile within a small mature Teak, Jam and *Acacia* plantation, 20 October 2007, 1900 h.

Microhyla berdmorei (Blyth, 1856)

CHITTAGONG DIVISION, Rangamati District, Kaptai: JUHG 0077–0079, 0114–0116 adults (22°28'N, 92°13'E), from Kaptaimukh Beat, ~2m from small slow moving stream in a cleared forest habitat, with bushy vegetation, 3 September 2007 and 18 October 2007, 1930 h. JUHG 0085–0086, 0101, 0112, 0117 adults (22°30'N, 92°12'E), from the lawn of F.D.T.C. Officers Hall on the outskirts of Kaptai Village within several meters from the edge of a patch of mature tropical semi-evergreen forest, 1–2 September 2007 and 17 October 2007, 1930 h.

Bandarban District, Bandarban, Milonchari: JUHG 0152, 0159, 0172–0173 adults (22°10'N, 92°13'E), collected from within and around a concrete reservoir near the border of the H.R. The reservoir is bordered by a small jhum field and the same stream described above for *Occidozyga* cf. *borealis*. One male was collected while calling from a narrow, slow-moving stream bordering the road outside the H.R., 11–15 November 2007, 1030–2030 h.

DHAKA DIVISION, Tangail District, Rasulpur, Madhupur N.P.: JUHG 0211 (24°41'N, 90°08'E), from a roadside verge, 7 December 2007, 1750 h.

Microhyla ornata (Duméril and Bibron, 1841)

CHITTAGONG DIVISION, Cox's Bazar District, Chokoria: JUHG 0038–0039, 0042 adults, from the Faishakhali F.O. at Malumghat, collected on soil surrounding wood piles within a mature Teak, Jam and *Acacia* plantation, 20 October 2007, 1900 h. Eidgaon, Bomarighona F.O.: JUHG 0040–0041 adults, from within grass surrounded wood piles in a mature mixed Teak and *Acacia* plantation, 21 October 2007, 1330 h.

Rangamati District, Kaptai, Kaptai Village: JUHG 0111, 0114 adults (22°30'N, 92°12'E), 1 September 2007

Bandarban District, Bandarban, Milonchari: JUHG 0153 adult (22°10'N, 92°13'E), collected from grass next to a small man made pond in a jhum field on the outer edge of the H.R., 14 November 2007, 1100 h.

SYLHET DIVISION, Hobiganj District, Chunarughat, Rema Kalenga W.S.: JUHG 0242 adult, 11 May 2007.

Maulvibazar District, Sreemangal, Lawachara N.P.: JUHG 0014 adult (24°19'N, 91°47'E), from leaf litter, 19 May 2007, 1830 h.

DHAKA DIVISION, Tangail District, Rasulpur, Madhupur N.P.: JUHG 0212 adult (24°41'N, 90°08'E), from amongst leaf litter, 12 July 2007, 1755 h.

Dhaka District, Savar, J.U.: JUHG 0008 adult (23°52' N, 90°16′ E), from a roadside grassy verge, 17 June 2007, 1910 h.

Uperodon globulosus (Günther, 1864)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0009, 0257 males (23°52'N, 90°16'E), 1994.

Tangail District, Rasulpur, Madhupur N.P.: JUHG 0215–0216 juveniles (24°41'N, 90°08'E), from a forest edge, beside an existing forest trail, 13 July 2007, 1840 h.

Remarks.– Previously reported from Madhupur, Mymensingh District in 1980 (Khan, 2004).

Rhacophoridae

Chiromantis vittatus (Boulenger, 1887)

SYLHET DIVISION, Maulvibazar District, Sreemangal, Lawachara N.P.: JUHG 0011 refer to Kabir et al. (in press) for a detailed description of this specimen.

Philautus sp.

CHITTAGONG DIVISION, Bandarban District, Bandarban, Milonchari: JUHG 0187 (22°10'N, 92°13'E), collected from a stem of a plant (1 m a.g.l.), overhanging a small slow moving roadside stream next to a bushy area of natural vegetation, 13 November 2007, 2100 h.

Remarks.– The taxonomic identity of this individual is currently unclear, however it does show some similarity to *P. parvulus*.

Polypedates leucomystax (Gravenhorst, 1829)

CHITTAGONG DIVISION, Cox's Bazar District, Chokoria, Malumghat: JUHG 0044 subadult, on the grounds of the Faishakhali F.O., on a low-lying plant near wood piles in a mature Teak, Jam and *Acacia* plantation, 20 October 2007, 1900 h.

Bandarban District, Bandarban, Milonchari: JUHG 0156–158 adults (22°10'N, 92°13'E), all three specimens collected from within the H.R. Two were found active on banana trees at ~3 m a.g.l. bordering a narrow stream and one was collected at ~2.3 m a.g.l., on a tree in a disturbed habitat, 14–15 November 2007, 1930–2015 h.

Rangamati District, Kaptai, Kaptai Village: JUHG 0105–0106 adults (22°30'N, 92°12'E), 1 September 2007.

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0261–0263 adults (23°52'N, 90°16'E), 2004.

Megophryidae

Leptobrachium smithi Matsui, Nabhitabhata & Panha, 1999

SYLHET DIVISION, Maulvibazar District, Sreemangal, Lawachara N.P.: JUHG 0015 (24°19'N, 91°48'E), from beside a chara (small spring), 18 May 2007, 2015 h.

Gekkonidae

Cyrtodactylus sp.

CHITTAGONG DIVISION, Rangamati District, Kaptai: JUHG 0010 adult (22°28'N, 92°13'E), from Kaptaimukh Beat, ~1 m from a slow moving stream on a tree trunk at 1 m a.g.l., 18 October 2007, 1830 h. JUHG 0059–0061, 0125–127 adults (22°30'N, 92°12'E), two found on the vertical mud bank of a small slow moving stream in a selectively felled and disturbed mixed semi-evergreen and Teak forest patch at the edge of Kaptai Village, the third found on a vertical mud ditch, 1 m a.g.l., at the edge of an immature secondary mixed forest patch with dense undergrowth, 1–2 September 2007 and 18 October 2007, 2300–2330 h.

Bandarban District, Bandarban, Milonchari: JUHG 0161–0162, 0195–197 adults (22°10'N, 92°13'E), all except one individual were collected within 1 m from the edge of streams, perched on the stems of small plants and bamboo to up to 1 m a.g.l. One specimen was collected ~200 m from the nearest stream, on the base of a concrete support pillar of a guest room of the H.R. 13–17 November 2007, 1830–2100 h.

Remarks.– Previously reported from Bandarban by Mahony and Ali Reza (2007a) based on a single specimen and commented to be similar in general appearance to *C. ayeyarwadyensis* Bauer, 2003. Further work is being carried out on our recent larger collection of this species to determine its specific identity.

Gekko gecko azhari Mertens, 1955

CHITTAGONG DIVISION, Cox's Bazar District, Chokoria, Malumghat: JUHG 0051–0070 juveniles, from the compound of the Faishakhali R.O., on the trunk of a sapling 30 cm a.g.l., within a mature Teak, Jam and *Acacia* plantation, 20 October 2007, 1900 h.

Bandarban District, Bandarban, Milonchari, H.R.: JUHG 0138 juvenile (22°10'N, 92°13'E), on an outside wall of one of the guest rooms, in a part of the resort where several of the original semi-evergreen tree species remain, 11 November 2007, 2000 h.

Rangamati District, Kaptai: JUHG 0128 adult (22°28'N, 92°13'E), from Kaptaimukh Beat, 3 September 2007. JUHG 0129 adult (22°30' N,

92°12' E), from Kaptai Village, 1 September 2007.

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0270 adult (23°52'N, 90°16'E), 1992.

Hemidactylus cf. *bowringii* (Gray, 1845)

CHITTAGONG DIVISION, Rangamati District, Kaptai, Kaptai Village: JUHG 0027–0028, 0062, 0069 juveniles to adult (22°30'N, 92°12'E), all collected from the boundary wall of the F.D.T.C. Student Hall situated at the edge of the village, 17–18 October 2007, 2200–2330 h.

Cox's Bazar District, Chokoria, Malumghat: JUHG 0023, 0056–0058 subadults and adults, from the compound of the Faishakhali R.O., three collected from log piles within a mature Teak, Jam and *Acacia* plantation and one from the external smooth white wall of an office building, 20 October 2007, 1845–1900 h. JUHG 0054–0055 adults, collected from the wooden veranda of the Dulahazara Safari Park Forestry Guest House, 20 October 2007, 2300 h.

Remarks.– This species is a representative of the *Hemidactylus bowringii* complex and may prove conspecific with one of the recently described Myanmar species (McMahan and Zug, 2007). Our collections here consist of primarily immature individuals, thus a larger collection of adults will be required to determine its affinities with the Myanmar species.

Hemidactylus cf. *brookii* Gray, 1845

DHAKA DIVISION, Dhaka District, Savar: JUHG 0200 female (23°52'N, 90°16'E), from an inner wall on the second floor of the Teacher Student Center building in J.U., 18 November 2007, 2200 h. JUHG 0219–0224 juveniles to adults, from the external walls of buildings within the BLRI compound, October 2007.

Remarks.– *Hemidactylus brookii* is yet another complex of cryptic species (Carranza and Arnold, 2006; and Mahony, unpubl. data) thus the specific identity of our Bangladesh collection remains obscure pending further clarification of the *brookii* complex.

Hemidactylus frenatus Schlegel, 1836

CHITTAGONG DIVISION, Rangamati District, Kaptai: JUHG 0029–0034, 0068, 0131–0135 adults (22°30'N, 92°12'E), all collected from the boundary walls of the F.D.T.C. Student Hall and from the building itself, on the outskirts of Kaptai Village, 1–2 September 2007 and 17 October 2007, after 1600 h. JUHG 0130 adult (22°28'N, 92°13'E), from Kaptaimukh Beat, 3 September 2007.

Cox's Bazar District, Chokoria, Malumghat: JUHG 0024, from the compound of the Faishakhali R.O., collected from a log pile within a mature Teak, Jarul and *Acacia* plantation, 20 October 2007, 1845 h.

Bandarban District, Bandarban, Milonchari, H.R.: JUHG 0169–0170, 0180 adults (22°10'N, 92°13'E), all collected from the outer walls of the dorm building, around lights, 15 November 2007, 1730 h.

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0201, 0218 adults (23°52'N, 90°16'E), collected from an external wall on the second story of the Teacher Student Center building, 18 November 2007, 2200 h.

Tangail District, Rasulpur, Madhupur N.P.: JUHG 0210 male (24°41'N, 90°08'E), from a wall of the forest rest house, under a light bulb, 15 July 2007, 2230 h.

Hemidactylus garnotii Duméril and Bibron, 1836

CHITTAGONG DIVISION, Bandarban District, Bandarban, Milonchari, H.R.: JUHG 0198 female (22°10'N, 92°13'E), collected from the outer wall of the dorm building, next to a banana tree, 11 November 2007, 1730 h.

Remarks.– This species was first reported in Bangladesh based on a photo-voucher from Bandarban, Mahony and Ali Reza (2007a).

Hemidactylus cf. *platyurus* (Schneider, 1792)

CHITTAGONG DIVISION, Rangamati District, Kaptai Village: JUHG 0026, 0124 adults (22°30'N, 92°12'E), collected from a light on the boundary wall of the F.D.T.C. Officers Hall, 2 September 2007 and 17 October 2007, 2200 h.

Cox's Bazar District, Chokoria, Malumghat: JUHG 0024 adult, from near the Faishakhali R.O. compound, on the trunk of a tree at 1.8 m a.g.l., within a mature Teak, Jam and *Acacia* plantation, 20 October 2007, 2000 h.

Bandarban District, Bandarban, Milonchari, H.R.: JUHG 0163–0168, 0199 adults (22°10'N,

92°13'E), all collected from the outer walls of the dorm building, 12–16 November 2007, after 1730 h.

DHAKA DIVISION, Tangail District, Rasulpur, Madhupur N.P.: JUHG 0208–0209 adults (24°41' N, 90°08' E), under the bark of a Sal tree, 15 July 2007, 1020 h.

Remarks.– These specimens conform with the general description of *Hemidactylus platyurus* in the literature, however, this species is recognised as a complex of genetically distinct cryptic species (Bauer, 2000; Carranza and Arnold, 2006).

Scincidae

Eutropis macularia (Blyth, 1853)

CHITTAGONG DIVISION, Rangamati District, Kaptai Village: JUHG 0025, 0067, 0123 subadult and adults (22°30'N, 92°12'E), all collected from outside the boundary wall of the F.D.T.C. Students Hall, on a roadside verge with patches of dense bushy vegetation, 1 September 2007 and 17 October 2007, 2215 h.

Bandarban District, Bandarban, Milonchari, H.R.: JUHG 0139, 0171 adults (22°10'N, 92°13'E), from the outer boundary of the resort, in an area dominated by grass/weeds alongside a jhum field, 11 & 14 November 2007, 1930 h and 1030 h, respectively.

SYLHET DIVISION, Maulvibazar District, Sreemangal, Kalachara (West Bhanugach Forest Reserve): JUHG 0204 subadult (24°23' N, 91°48' E), from a hole in the ground, 19 May 2007, 1420 h.

DHAKA DIVISION, Tangail District, Rasulpur, Madhupur N.P.: JUHG 0214 juvenile (24°41'N, 90°08'E), amongst leaf litter on the forest floor, 15 July 2007, 1240 h.

Eutropis multifasciata (Kuhl, 1820)

CHITTAGONG DIVISION, Cox's Bazar District, Eidgaon, Bomarighona F.O.: JUHG 0066 adult, in grass near log piles within a mature mixed plantation of Teak and *Acacia*, 21 October 2007, 1400 h.

Bandarban District, Bandarban, Milonchari: JUHG 0279 adults (ca. 2 km east of 22°10'N, 92°13'E), collected from the bank of a narrow slow-moving stream, surrounded by rice paddy in the Sangu River valley below the H.R., 16 November 2007, 1200 h.

SYLHET DIVISION, Maulvibazar District, Sreemangal, Lawachara N.P.: ZRC(IMG) 2.96 subadult (24°19'N, 91°47'E), collected by M.A., photographed by S.M., July 2006.

DHAKA DIVISION, Dhaka District: JUHG 0267, 0268 adults (23°52'N, 90°16'E), collected from the J.U. campus, Savar, 1994 and 2004. JUHG 0269 adult, collected from Dakhinkhan, Uttara, 2003.

Remarks.– The authors can find no previous records of *E. multifasciata* from Bangladesh, however, it is well documented from north-east India (Smith, 1935; Das, 2008).

Sphenomorphus maculatus (Blyth, 1853)

CHITTAGONG DIVISION, Rangamati District, Kaptai: JUHG 0052 adult (22°30'N, 92°12'E), on grassy area of a forest clearing next to a small, slow-moving stream, near the F.D.T.C. Officers Hall, on the outskirts of Kaptai Village, 18 October 2007, 1300 h. JUHG 0053 subadult, collected 10 km from Kaptaimukh Beat (22°28'N, 92°13'E), from the bottom of a log pile, next to a disused mud road surrounded by undisturbed semi evergreen forest, 18 October 2007, 1100 h.

Bandarban District, Bandarban, Milonchari, H.R.: JUHG 0143–0144 subadult and juvenile (22°10'N, 92°13'E), from the bank of a narrow, cascading stream bordered by a narrow strip of natural semi-evergreen forest vegetation, 14 November 2007, 1230–1300 h.

Agamidae

Calotes emma Gray, 1845

SYLHET DIVISION, Maulvibazar District, Sreemangal, Lawachara N.P.: JUHG 0207, 0239 juvenile and adult (24°19'N, 91°47'E), collected from a bush and a tree, 8 April 2008 and 21 May 2007, 1020 h and 1325 h.

Calotes cf. *versicolor* (Daudin, 1802)

CHITTAGONG DIVISION, Rangamati District, Kaptai Village: JUHG 0063–0064, 0112 subadults and adult (22°30'N, 92°12'E), collected from the roadside within grassy area, surrounded by dense bushes and several trees, 2 September 2007 and 18 October 2007, 1030 h.

Cox's Bazar District, Chokoria, Malumghat: JUHG 0050, 0065 subadults, from a bushy area by the roadside, bordering a mature Teak, Jam and *Acacia* plantation, 20–21 October 2007, 1130 h and 1500 h.

Bandarban District, Bandarban, Milonchari, H.R.: JUHG 0140–0142, 0177 subadult and adults (22°10'N, 92°13'E), two were caught next to paths amongst grass and low weeds, 13–14 November 2007, 0930 and 1300 h. Two specimens were collected ca. 1 km uphill from the H.R., on the way to Tiger Hill, one from next to a path with dead vegetation surrounded by bushes and the other from the edge of a banana plantation bordering a Teak plantation, 15 November 2007, 1400 h.

SYLHET DIVISION, Maulvibazar District, Sreemangal: JUHG 0206 adult (24°19'N, 91°46'E), collected from the edge of a forest trail in Lawachara N.P., 21 May 2007, 1410 h. JUHG 0237–0238 males (24°15'N, 91°46'E), collected from M. R. Khan Forest, 29 March 2008, 1140–1150 h.

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0230 subadult (23°52'N, 90°16´E), from behind the Al-Beruni (student) Hall, December 2007. JUHG 0274–0275 adults, 2003 and 2004.

Remarks.– Our collection appears to represent possibly two distinct species from the *Calotes versicolor* complex, however, further collections from Bangladesh are required to determine the species boundaries and have a better understanding of morphological variation within and between these populations.

Draco maculatus (Gray, 1845)

CHITTAGONG DIVISION, Rangamati District, Kaptai Village: JUHG 0121 subadult (22°30'N, 92°12'E), collected from a tree at ca. 10 m a.g.l., 3 September 2007.

Remarks.– This specimen conforms in overall morphology to a syntype (BMNH 1946.8.27.5) examined by S.M.

Ptyctolaemus gularis (Peters, 1864)

SYLHET DIVISION, Maulvibazar District, Sreemangal, Lawachara N.P.: JUHG 0240 (24°19'N, 91°47'E), collected from a bush, 30 March 2008, 1522 h.

Varanidae

Varanus bengalensis (Daudin, 1802)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0277 (D) adult (23°52'N, 90°16´E), 1989.

Varanus flavescens (Hardwicke & Gray, 1827)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0236 juvenile (23°52'N, 90°16´E), from beside the Bangabandhu Student's Hall, on grass, beside a permanent water body and paddy field, 23 March 2008, 1020 h. JUHG 0278 (D) adult, from a lake in JU campus, 1998.

Varanus salvator Laurenti, 1768.

BARISAL DIVISION, Barisal District, Ujirpur: ZRC(IMG) 2.94 adult (22°49'N, 90°15'E), photographed at a betel cultivation field, on the bank of a big river, 4 June 2007, 1257 h.

KHULNA DIVISION, Bagherhat District, Sundarbans, Karamjal: ZRC(IMG) 2.95 adult (22°25.457'N, 89°35.647'E), from mangrove forest, resting on a tree at about 12 m a.g.l., 6 September 2007, 0825 h.

Colubridae

Ahaetulla nasuta (Lacépède, 1789)

CHITTAGONG DIVISION, Chittagong District, Sitakunda, Chandranath Hill: JUHG 0255 adult, found killed by locals, February 2004, ~1045 h.

Amphiesma stolata (Linnaeus, 1758)

CHITTAGONG DIVISION, Bandarban District: JUHG 0249 adult, no exact locality or habitat data available, 1990.

Boiga ochracea walli Smith, 1943

CHITTAGONG DIVISION, Bandarban District, Bandarban, Milonchari: JUHG 0193 subadult (22°10'N, 92°13'E), actively foraging on top of a small tree at ~4 m a.g.l. which was overhanging a small concrete reservoir, within the compound of the H.R., 15 November 2007, 1800 h. JUHG 0234 juvenile, collected from an exposed leaf of a felled banana tree, in a banana plantation near Tiger Hill, ca. 2 km from H.R., 16 November 2007, 1300 h.

Rangamati District, Kaptai, Kaptai Village: JUHG 0233 subadult (22°30'N, 92°12'E), at 3 m a.g.l. climbing a tree trunk on the roadside near the F.D.T.C., 17 October 2007, 2300 h.

Remarks.– When collected, the juvenile JUHG 0234, had a single dead red weaver ant (*Oecophylla smaragdina*) attached by its mandible to the snake's back. The area surrounding the bite site was discoloured grey when collected. This individual was kept in captivity for 3 weeks to observe if the snake suffered any further ill effects of the bite. By the fourth day it began feeding readily on a juvenile *Hemidactylus,* and after two sheds, the grey patch decreased in size significantly.

Chrysopelea ornata (Shaw, 1802)

JUHG 0250 adult, this individual was bought from a snake charmer at the Snake Charmers Village, Savar, Dhaka, 1989. The actual collection locality is unknown. Snakes displayed at this snake charmers village are collected from throughout Bangladesh and many others are smuggled into Bangladesh from India.

Enhydris enhydris (Schneider, 1799)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0194 subadult (23°52'N, 90°16′E), collected from beside the old Zoology Department building, on a path ca. 20 m from a lake, 20 November 2007, 1130 h.

Lycodon aulicus (Linnaeus, 1758)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0217 adult (23°52'N, 90°16′E), one was collected from inside a student dorm, December 2007. JUHG 0235 adult, found inside the field laboratory of the Wildlife Rescue Center of J.U., 26 October 2007, 1240. JUHG 0254 adult, exact locality not recorded, 1990.

Oligodon taeniolatus (Jerdon, 1853)

SYLHET DIVISION, Maulvibazar District, Kamalganj, Adampur: JUHG 0245 adult (24°15'N, 91°53'E), collected from under a tree, June 2002, 1140 h.

Ptyas mucosa (Linnaeus, 1758)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0253 adult (23°52'N, 90°16′E), specimen was killed on campus by a gardener, 2007, 1020 h. JUHG 0265–0266 adult, no locality data available, apart from being within J.U. campus, 1994 and 2003.

Rhabdophis subminiatus (Schlegel, 1837)

CHITTAGONG DIVISION, Bandarban District, Bandarban, Milonchari, H.R.: JUHG 0232 subadult (22°10'N, 92°13'E), from the bank of a narrow, cascading stream bordered by a narrow strip of natural semi-evergreen forest vegetation, 15 November 2007, 1300 h.

CHITTAGONG DIVISION, Cox's Bazar District, Teknaf, Teknaf (town): JUHG 0252 adult (20°53'N, 92°18'E), found killed by locals on the roadside next to a paddy field, 2004, 1310 h.

Rhabdophis sp.

SYLHET DIVISION, Maulvibazar District, Sreemangal, Lawachara N.P.: JUHG 0205 adult (24°19'N, 91°47'E), emerged from water and entered a grassy area beside a railway line, 23 May 2007, 1140 h.

Remarks.– The specific identity of this specimen could not be verified and must be compared to several little known species from the genus which it may in future prove conspecific, or perhaps represent a currently undescribed species. This specimen appears similar to an individual photographed in Das (2008) as *Rhabdophis* sp. from near Barail Hills in southern Assam.

Xenochrophis piscator (Schneider, 1799)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0236 adult female (23°52'N, 90°16′E), collected from inside the field laboratory of the Wildlife Rescue Center, 2005, 2230 h.

Elapidae

Bungarus fasciatus (Schneider, 1801)

CHITTAGONG DIVISION, Bandarban District, Bandarban, Milonchari, H.R.: JUHG 0202 adult (22°10'N, 92°13'E), from the base of a bamboo thicket, on the bank of a narrow, cascading stream bordered by a narrow strip of natural semi-evergreen forest vegetation, 15 November 2007, 1930 h.

Naja kaouthia Lesson, 1831

KHULNA DIVISION, Bagherhat District, Sundarban N.P., Kachikhali: JUHG 0136 juve-

nile (21°52'N, 89°50'E), from amongst grasses next to an estuarine river during low tide, February 2004.

Naja naja (Linnaeus, 1758)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0264 adult (23°52'N, 90°16'E), killed at night by local people, next to their house, 1994.

Hydrophiidae

Enhydrina schistosa (Daudin, 1803)

KHULNA DIVISION, Bagherhat District, Sundarban N.P., Dublarchar: JUHG 0246 adult (21°43'N, 89°36'E), from an estuarine river bank, during low tide, 1996.

Hydrophis cyanocinctus Daudin, 1803

KHULNA DIVISION, Bagherhat District, Sundarban N.P., Dublarchar: JUHG 0251, 0280 adults (21°43'N, 89°36'E), on the mud of an estuarine river bank, during low tide, December 1991 and 1996.

Pelamis platura (Linnaeus, 1766)

"Bangladesh, coastal area": JUHG 0248 adult, collected from fishermen while landing fish at a harbour, 1988.

Crotalidae

Cryptelytrops erythrurus (Cantor, 1839)

CHITTAGONG DIVISION, Rangamati District, Kaptai Village: JUHG 0231 male (22°30'N, 92°12'E), from the edge of a trail in a moderately disturbed patch of tropical semi-evergreen forest, on the outskirts of Kaptai Village, 18 October 2007, 1900 h.

Typhlopidae

Ramphotyphlops braminus (Daudin, 1803)

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0203, 0229, 0272 adults (23°52'N, 90°16'E), from the flower garden at the Fajilatunnessa Student's Hall, 2006 and April, 2007.

SYLHET DIVISION, Maulvibazar District, Sreemangal, Lawachara N.P.: JUHG 0256 adult (24°19'N, 91°47'E), found dead on the road, 2002, 0700 h.

Typhlops diardii Schlegel, 1839

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0276 adult (23°52'N, 90°16'E), found on a grass area bordering a road, 23 March 2008, 0130 h.

Boidae

Gongylophis conicus conicus (Schneider, 1801)

DHAKA DIVISION, Dhaka District, Savar: JUHG 0271 adult, bought from a snake charmer at the Snake Charmers Village, in the suburbs of Savar, original collection site unknown, 1987.

Trionychidae

Lissemys punctata andersoni Webb, 1980

DHAKA DIVISION, Dhaka District, Savar, J.U.: JUHG 0273 adult (23°52'N, 90°16'E), from a lake on campus, 1990.

Testudinidae

Indotestudo elongata Blyth, 1854

CHITTAGONG DIVISION, Cox's Bazar District, Inani Forest: ZRC(IMG) 2.97 adult (21°12'N, 92°04'E), the individual photographed was collected by local people and is currently kept at the Dulahazara Safari Park, collected June 2006.

Discussion

The collection is presented here for the purpose of providing species specific localities and collection habitats for many species previously only reported from Bangladesh in country checklists with often vague or no locality data and rarely based on collections of specimens. This understandably leads to confusion as such anecdotal records of species can not be later verified for the identifications made by these authors. This is often essential especially as wide ranging species complexes continue to be split into recognisable distinct species. In this circumstance, it is usually necessary to have a comprehensive collection of referable material to verify which of the newly evaluated species is extant from each country, or each part of a country. In the case of Bangladesh, even a basic collection of the most common species is not available internationally in specimen repositories. Though

many of the species presented here are assumed to be "common" or "widespread" throughout Bangladesh and surrounding countries, until now most of these species are actually verified in literature from perhaps only one or two specific localities in Bangladesh. Accurate conservation assessments for such species if or when necessary in the future can not be carried out based on anecdotal records or assumptions of species distribution in a country, therefore adding further importance to verifying localities for species even within generally "assumed" natural ranges. In this respect, it should be considered that the vast majority of the original habitat in Bangladesh has been completely cleared and, or at least, considerably altered by human activities, thus sweeping statements of species distributions are in most cases gross overestimates of the current distribution and should be avoided by future researchers.

Here we would like to take the opportunity to comment on previous literature where sufficient information was provided, to allow corrections to be made. Corrections to Khan (2007) were addressed in Mahony and Ali Reza (2007a). Mahony and Ali Reza (2007c) and Ali Reza and Mahony (2007) reported *Kaloula taprobanica* and *Sylvirana* (*Hylarana*) *leptoglossa* as new locality records for Mymensingh District. We have, since, come across an older record of both species from Mymensingh, "Bengal" (Romer, 1949). The *Kaloula taprobanica* (as *Kaloula pulchra taprobanica*) specimens from "(?Jogandranagar)" were originally reported to be deposited at the BMNH. The repository of the *Hylarana leptoglossa* collection was not mentioned in that paper, but is also represented in the BMNH by a single specimen (BMNH 1947.1.1.71). Ali Reza (2007, 2008a–b) had several errors, e.g., providing first country records of *Occidozyga borealis*, *Scincella reevesii*, *Ptyctolaemus gularis*, *Sphenomorphus maculatus*, and possibly *S. indicus*. *Occidozyga borealis* was previously recorded from the Rangamati area by Asmat (2005). The record (and photograph) of *Scincella reevesii* is of a breeding male *Sphenomorphus maculatus* from Milonchari, Bandarban (Mahony and Ali Reza, 2007a). *Ptyctolaemus gularis* was previously recorded from "Nainimukh, Chittagong Hill Tracts" based on a specimen deposited at the ZSI (Hora, 1926). *Sphenomorphus maculatus* is listed by Ahsan (1998: as *Lygosoma*), Khan (2004) and Khan (2007) also provide a brief comment and photograph. The record of *S. indicus* from the Tipperah Hills, Comilla, is likely based on the single specimen collected in the presence of the first and fifth authors (this report). It was provisionally referred to as *S. indicus* in the field, but is instead referable to a female *S. maculatus*, with a clearly concave rostral scale. Until specimens of verified identification of *Scincella reevesii* and *Sphenomorphus indicus* are discovered, both species should not be considered extant in Bangladesh.

Because many important literature records of Bangladesh herpetofauna are sporadically distributed throughout often little known publications, the need for correcting published errors of the past and present is essential when attempting to understand the current status of the country's herpetofauna and preventing future researchers from duplicating these errors in their own work. A typical circumstance of taxonomic confusion can be explained with the example of the species *Rana* (*Hylarana*) *erythraea* (Ahsan, 1998; Khan, 2001, 2004), *R.* (*Hylarana*) *taipehensis* (Romer, 1951; Khan, 2004) and *Hylarana tytleri* (Ahsan, 1998; Choudhury, 1996; Ohler and Mallick, 2002; Asmat et al., 2003) all of which have been considered to be present in Bangladesh. Romer (1951) clarified his previous record of *R. erythraea* from Mymensingh to be *R. taipehensis*, later Ohler and Mallick (2002) reviewed this problematic group and restricted all Indian and Bangladesh populations to *Hylarana tytleri*, thus *H. erythraea* and *H. taipehensis* should no longer be considered present in Bangladesh until specimens of verified identity are clearly diagnosed. A species apparently not included in any previous checklist from Bangladesh is *Takydromus khasiensis* represented by three specimens in the collection of the California Academy of Science (CAS 94297–94299) that were collected from Lawachara N. P. in Sylhet Division by E. S. Ross and D. Cavagnaro in 1961 (CAS, 2007—online reference).

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Herpetological surveys along Pagdanan Range and Dumaran Island, northern Palawan, Philippines

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(with eight text-figures)

ABSTRACT.- **In this paper, we contribute to the knowledge of amphibians and reptiles of Pagdanan Range and adjacent areas in northern Palawan, Philippines. We present findings of herpetological surveys at five sites. A total of 12 amphibian and 31 reptile species were recorded. Five of these are categorized by IUCN as "threatened", and two are considered "near threatened". Based on the results of this study, three species are recommended for IUCN status assessment. Ten species are Palawan endemics. Alteration and destruction of lowland forest habitats are major threats common to all species. Habitat and site-based conservation measures are needed to avoid local extinctions of these and other threatened species.**

KEYWORDS.- **Herpetofauna, Palawan, Philippines, key conservation species.**

Introduction

The herpetological fauna of the Philippines is extremely diverse (Brown et al., 2002) and is recognized as one of the most important centers of herpetofaunal diversity in south-east Asia (Diesmos et al., 2001). Knowledge on the conservation status of amphibians and reptiles found in Palawan was reported nonexistent (Herp Watch Palawan, 2001) and is still insufficient. This is especially true for Pagdanan Range despite the fact that the area has been designated as one of the Key Biodiversity Areas of the Philippines (Anda and Tabangay-Baldera, 2004).

The Pagdanan Range on Palawan Island comprises old-growth forest between the boundaries of the municipalities of Roxas, San Vicente and Taytay. The maximum altitude of the range is 701 m, the entire area thus covered by lowland and submontane forest. None of the forests is officially protected at present; however, an integrated management plan has been prepared for the Palawan Biosphere Reserve under Environmentally Critical Areas Network (ECAN), which aims to zone the island according to different intensities of human activities. From 1975–1993, the forests in San Vicente, Taytay and Roxas were commercially logged by Pagdanan Timber Products, which mainly targeted hardwood species of the Dipterocarpaceae. This has significantly reduced the forest area and quality of Pagdanan Range. Roxas and Taytay were considered illegal logging hotspots of Palawan (Anda and Tabangay-Baldera, 2004).

Our intention is to contribute to the knowledge of amphibians and reptiles of Pagdanan Range and adjacent areas. Special attention is given to threatened and near threatened species since this information is deemed useful for future evaluation of local and global conservation status. Surveys along the Pagdanan Range were part of the Katala Quest Project to assess the threatened vertebrate fauna within the habitats of the critically endangered Philippine Cockatoo in northern Palawan (Widmann et al., 2004).

Methodology

Surveys were conducted in the Key Biodiversity Areas, as identified in Anda and Tabangay-Baldera (2004) in northern Palawan, covering Sitio Binaluan, Barangay Liminancong, Taytay; Barangay Kemdeng, San Vicente; Barangay Il-

ian, Dumaran and Roxas along the Pagadanan Range, and Sitio Lagan, Barangay San Juan and Barangay Sto. Tomas on Dumaran Island (Fig. 1). Surveys were conducted in November 2002 (Sto. Tomas and Lagan), February 2003 (Ilian and Sto. Tomas), May and October 2003 (Sto. Tomas), November 2003 (Binaluan), January 2004 (Kemdeng) and from March to May 2007 (Roxas and Sto. Tomas). In February 2003, only daytime visual encounter surveys were conducted. Surveys in 2007 aimed at assessing the population size of the threatened Philippine Forest Turtle, *Siebenrockiella leytensis*, hence surveys had been conducted in preselected sites where the species was relatively common.

Pagdanan Range is located at 10°46'N, 119°20'E. The area is characterized by excessively-logged lowland forest with large patches of agricultural lands and human settlements. However, there are still large tracts of old growth forest left in the area's interior. Maximum altitude in the area is 701 m. Organized commercial illegal logging activities are still ongoing, particularly within the forests between Roxas and San Vicente, as well as in the peripheral areas of Taytay. All survey sites lay in areas that were identified as physical and/or socio-economical land areas in need of protection to conserve target species (Anda and Tabangay-Baldera, 2004).

The site at Sitio Binaluan, which is part of the Malampaya Sound, is peripherally connected to the Pagdanan Range. Vegetation consists of over-logged lowland forest, mangrove areas and patches of agricultural lands. The survey area in Kemdeng is located in the northwest coast of Palawan. Vegetation consists of over-logged lowland forest and extensive meadows for water buffalos, with scattered rice fields, small wetlands and shrubs. A perennial river is bordered by disrupted stretches of riparian vegetation. The Ilian River is one of the larger river systems in northern Palawan. The river banks in its watershed area are bordered by mangrove vegetation reaching far upriver. The valley floor is mainly under cultivation (fruit plantations, upland and irrigated rice, and coconut grooves). The slopes are still forested, but encroachment through shifting cultivation and illegal logging are rampant. The survey site in Roxas is highly disturbed and degraded by slash and burn farming (*'Kaingin'*) practices with only few trees remaining. Sitio Lagan contains one of the largest mangrove areas on Dumaran Island. Other natural vegetation forms are beach forests and minuscule patches of coastal forest. The site in Sto. Tomas is characterized by one of the last remaining forest patches on western Dumaran Island. The site is ca. 60 ha of over-logged lowland forest, surrounded by shifting cultivation and large areas of secondary bamboo growth intercepted by the only perennial stream in the area.

Visual encounter surveys were conducted daily between 0600-1000 h and 1730-1200 h. Animals were collected by hand, scoop-netting, and pitfall trapping. Baited funnel traps were used to capture turtles at Roxas and Santo Tomas. Abundance of species was categorized as rare, common, or abundant if an average of 1–10, 11–20 or ≥ 21 individuals, respectively, were encountered at the survey sites (Diesmos, 1998). Standard size measurements up to 150 mm were taken with vernier calipers (to the nearest 0.1 mm), and then with tree calipers (to the nearest 1 mm), and mass measurements up to 60 g with a Pesola spring balance (to the nearest 0.1 g), and for heavier individuals, with top balances (to the nearest 10 g) for all species collected. For all threatened species, size ranges are given for adults and juveniles separately. Here, the term 'juvenile' will be used for those immature individuals that have not yet established external sexual dimorphism. In the absence of well established size ranges for the various life history stages, and difficulties in determining the sex of *Siebenrockiella leytensis* and *Cyclemys dentata*, individuals of *S. leytensis* with a median carapace length (MeCL) ≤ 200 mm were arbitrary classified as adults, while smaller individuals were classified as immature. For *C. dentata*, individuals smaller than 150 mm in MeCL were arbitrary classified immature. Sexes of *Cuora amboinensis* can easily be determined at MeCL of about ≥ 100 mm, smaller individuals are here grouped as juveniles.

Selected voucher specimens - excluding turtles - were euthanized via immersion in 50% ethyl alcohol, and preserved in 10% formalin solution. Voucher specimens are currently with the Katala Foundation, and will eventually be deposited with the National Museum of the Philippines, Manila.

The following references were used for identification and field collection methodology: Alcala (1986), Alcala and Brown (1998), Crump and Scott (1994), Diesmos (1998), Jaeger and Inger (1994), Lim and Lim (1992) and Zimmerman (1994).

Results and discussion

A total of 12 amphibian species were recorded from the survey sites (Appendix 1). All amphibians are IUCN red-listed (IUCN, 2007) as Endangered (1 sp.), Vulnerable (2 spp.), Near Threatened (1 sp.) or Least Concern (8 spp.) (Table 1). Five species are endemic to the Palawan group of islands. An additional frog species, *Kaloula picta* (IUCN least concern) was observed in a backyard in the municipality of Roxas. Among the species encountered, three (*Barbourula busuangensis, Megophrys ligayae,* and *Limnonectes acanthi*) had been identified as key conservation species of Palawan because they are threatened and/or are restricted range species (Anda and Tabangay-Baldera, 2004).

Thirty reptile species (14 snakes, 13 lizards, and three turtles) were recorded, of which two lizard species were observed but not identified (Appendix 1). In addition, we received secondary information from different occasions and informants on the existence of the Estuarine Crocodile *Crocodylus porosus* in the mangroves near Lagan, Dumaran Island. We have not yet verified these reports. Among the reptiles, five are endemic to Palawan (Table 1). Among all 31 species, two (*Siebenrockiella leytensis* and *C. porosus*) are key conservation species identified in the studies on the status of biological diversity in the Palawan corridor (Anda and Tabangay-Baldera, 2004). Two reptile species are threatened, one is near threatened, and one of Least Concern, following the latest IUCN criteria (Table 1).

In the following section, we discuss in detail the species we consider of conservation concern and that are listed as Threatened and Near Threatened by the IUCN (Table 1).

Threatened species

Palawan Horned Frog - *Megophrys ligayae* (Taylor, 1920)

This "Endangered" species was found in three of six sites (Appendix 1), where it was relatively

Table 1. IUCN Red List status and assessment of abundance in survey areas (this report).

Species	IUCN 2007	Palawan endemic	Abundance
Amphibians			
Barbourula busuangensis	VU	Yes	common
Bufo philippinicus	LC	Yes	abundant
Chaperina fusca	LC	No	rare
Leptobrachium cf. *hasseltii*	LC	?	rare
Limnonectes acanthi	VU	No	abundant
Megophrys ligayae	EN	Yes	common
Occidozyga laevis	LC	No	common
Polypedates leucomystax	LC	No	common
Polypedates macrotis	LC	No	rare
Rana moellendorffi	NT	Yes	abundant
Rana sanguinea	LC	Yes	common
Staurois natator	LC	No	common
Reptiles			
Ahaetulla prasina	none	No	rare
Boiga dendrophila multicincta	none	No	rare
Boiga schultzei	none	Yes	rare
Broghammerus reticulatus	none	No	rare
Chrysopelea paradisi	none	No	rare
Dendrelaphis sp.	none	No	common
Gonyosoma oxycephalum	none	No	rare
Lycodon subcinctus sealei	none	No	rare
Naja sumatrana	none	No	rare
Opisthotropis typicus	none	No	rare
Rhabdophis chrysargos	none	No	rare
Sibynophis bivittatus	none	No	rare
Trimeresurus schultzei	none	No	rare
Ramphotyphlops braminus	none	No	rare
Bronchocela cristatella	none	No	rare
Draco palavanensis	none	Yes	rare
Emoia atrocostata	none	No	rare
Eutropis indeprensa	none	No	common
Eutropis multifasciata	none	No	common
Gehyra mutilata	none	No	rare
Gekko athymus	none	No	rare
Gekko gecko	none	No	abundant
Gekko palawanensis	none	Yes	rare
Hemidactylus frenatus	none	No	rare
Varanus marmoratus	none	Yes	common
Crocodylus porosus	LR/lc	No	rare
Cuora amboinensis	VU	No	common
Cyclemys dentata	LR/nt	No	common
Siebenrockiella leytensis	CE	Yes	abundant

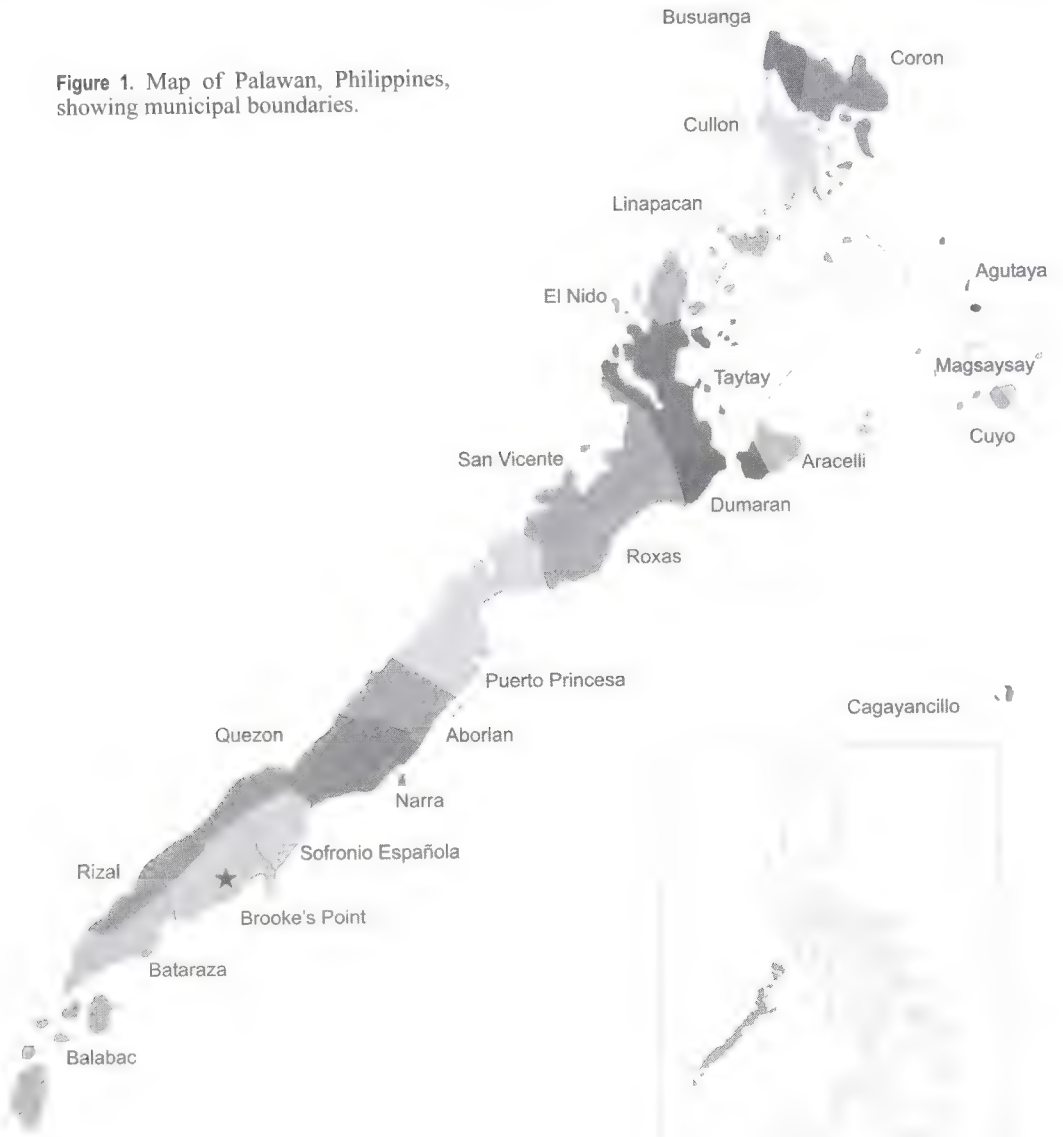

Figure 1. Map of Palawan, Philippines, showing municipal boundaries.

common and its characteristic call was the most dominant. Considering the localized commonness of the species, a reassessment of the IUCN status may be needed. Individuals were found on the forest floor on leaf litter and rocks, and on rocks or in crevices along the stream. The two adult voucher specimens ranged in snout-vent length (SVL) from 61.3–64.9 mm and in body weight (BW) from 22.5–24.0 g. The three juvenile vouchers measured between 20.3–28.9 mm in SVL and weighed between 1.8–3.0 g.

This species is a Palawan endemic, and recorded only from Balabac and Palawan Islands (Diesmos et al., 2004c). Assessors for the IUCN Red List assume that it is more widely distributed than current records suggest. We agree with Diesmos et al. (2004c) that the major threats are habitat loss caused by slash and burn farming, and the pollution of streams and rivers due to agricultural effluents and mine-tailings. The species has been identified as key conservation species by Anda and Tabangay-Baldera (2004).

Philippine Flat Headed Frog - *Barbourula busuangensis* Taylor and Noble 1924

This "Vulnerable" frog species was encountered in two of six sites. It is restricted to undisturbed, clear, unpolluted mountain streams of low elevations. During the survey, it was found in waterfall areas. This is in line with previous finding that report it as ".. commonly occurs in large numbers where known, though the overall distribution is patchy and fragmented" (Diesmos et al., 2004d). *Barbourula busuangensis* is a highly aquatic species that does not leave streams. It hides in crevices or under boulders in the stream bed during the day, and emerges with dusk to forage. Individuals show site-fidelity in respect to their retreats, and can be easily spotted at the entrance during night since their eyes reflect the light of a flashlight. Four of the voucher specimens were adults or close to adult size, and ranged in SVL from 68.0–102.9 mm and in BW from 35.0–83 g. The largest individual was a gravid female. One juvenile voucher measured 16.3 mm in SVL and weighed 1.0 g.

Barbourula busuangensis is endemic to the Palawan group of islands (Inger and Voris 2001). The species was first encountered in Busuanga by Taylor and Nobel (1924), and subsequently documented on Palawan by Myers (1943) and Alcala and Brown (1987). The species is known from four sites on Palawan Island: 1) Malampaya Sound, Palawan (this study), 2) San Vicente, Palawan (this study), 3) Narra, Palawan (Infante et al. 2002) and 4) Irawan, Puerto Princesa City, Palawan (Peneyra 2004).

The species is sensitive to habitat alteration, pollution and human disturbances which are all common phenomena around the range of *B. busuangensis*, especially in the central and northern Palawan. It is one of Palawan's key conservation species (Anda and Tabangay-Baldera, 2004). Alcala and Custodio (1995) believed that the logging ban in Palawan would help ensure the survival of the species in the Province. This might be true, given that logging is less prevalent in Palawan, than in other provinces. Nevertheless, deforestation is still an issue on Palawan, and its impact on the endemic fauna should not be underestimated. In addition, quarrying and mining activities in several river systems might contribute to the decline of *Barbourula* habitats. The exotic Taiwanese frog,

Figure 2. *Megophrys ligayae.*

Figure 3. *Barbourula busuangensis.*

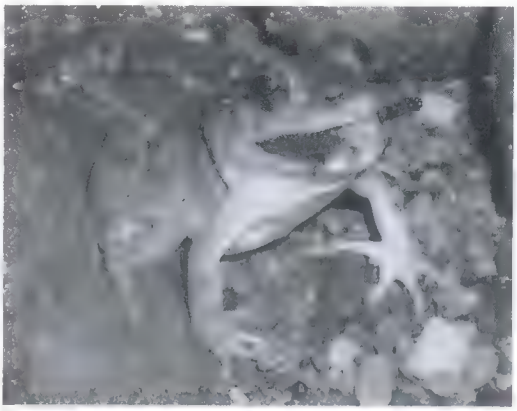

Figure 4. *Limnonectes acanthi.*

Figure 5. *Siebenrockiella leytensis.*

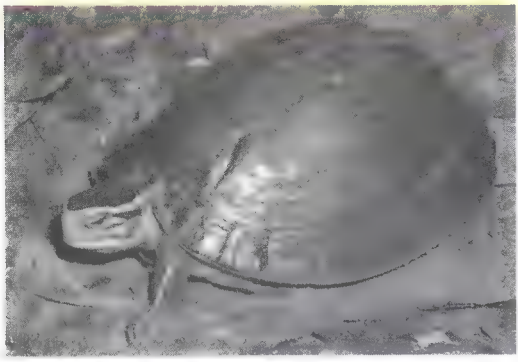

Figure 6. *Cuora amboinensis.*

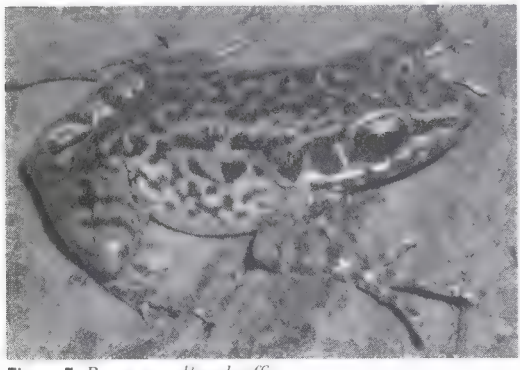

Figure 7. *Rana moellendorffi.*

Figure 8. *Cyclemys dentata.*

Hoplobatrachus chinensis that was introduced to the Philippines (Alcala and Brown 1998) and that was sighted in 2002 for the first time also in Palawan (A. Diesmos, National Museum of the Philippines, pers. comm. to SS in 2003) may pose an additional problem to the survival of *B. busuangensis*. Its distribution should be monitored. So far, *H. chinensis* was only recorded from Puerto Princesa City and Irawan (Diesmos et al., 2006).

Busuanga Wart Frog - *Limnonectes acanthi* (Taylor, 1923)

This "Vulnerable" species was found on all sites, except in Dumaran, and it is fairly abundant where it occurs. We encountered individuals on gravel, rock, leaf litter in or along the stream bed. We collected 11 voucher specimens including four juveniles. Adult specimens ranged in SVL from 45.3–62.0 mm and in BW from 13.5–30.0 g. Juveniles measured between 16.9–27.9 mm in SVL and weighed between 1.6 and 3.0 g. As an inhabitant of lowland forests, the most threatened ecosystems in Palawan, the main threat to this species is habitat loss. The species is one of Palawan's key conservation species (Anda and Tabangay-Baldera, 2004). Due to its large size, the species is potentially threatened by humans for food; fortunately, hunting pressures are not excessive on this species due to local preferences of humans on Palawan. Diesmos et al. (2004e) added pollution of streams and rivers from agricultural pesticides, herbicides, and mine-tailings to the threats to the species.

The species is endemic to the Philippines with records from the Palawan group of islands and Mindoro, but according to Diesmos et al. (2004e), taxonomic studies to determine the status of the various populations of this species are needed. Considering the abundance of the species in Palawan, while at the same time, taxonomic studies are needed, we recommend the species for IUCN status assessment.

Philippine Forest or Philippine Pond Turtle - *Siebenrockiella leytensis* (Taylor 1920)

This "Critically Endangered" species was sighted and collected in three of six sites, where it is familiar to the local inhabitants as *Bakoko* (Appendix 1). It inhabits slow flowing parts of

streams and rivers, where it spends the night foraging in water, daytime spent hidden in burrows in stream banks. A total of 83 individuals were encountered, which classifies it as abundant by the standards that were preset in this study. Only one individual was found in Kemdeng, all others were collected during mark-recapture surveys in Roxas and Dumaran. The high number of individuals encountered- even higher than other more widely distributed freshwater turtle species - is attributed to the fact that sites in Roxas and Dumaran are specific habitats of the species. The first author is currently conducting a long term study to determine trends in population size of the species at different sites (Schoppe, 2008). Results are expected to contribute significantly in the decision making process whether or not the Critically Endangered status of the species is still justified or whether the IUCN assessment of this species as CE should be reviewed and possibly downgraded.

Adults (n = 24) ranged in median carapace length (MeCL) from 201–283 mm and in body weight (BW) from 1180–3095 g. Fifty-nine individuals were by the size range that was set classified as immature. They ranged in MeCL from 46.3–198 mm and weighed between 18.0–1190 g. Among these, 21 individuals were smaller than 150 mm in MeCL. Determining the gender in this species requires experience, which some of our research assistants in this study did not have, hence we decided not to include datum on gender in the data analysis. There is however indication that subadult-hood and therewith external sexual dimorphism establishes at MeCL of about 150 mm (Schoppe, unpubl. data). Accordingly, 38 individuals could eventually be classified as subadult.

The mark recapture surveys permitted deeper insights into the conservation status of the species. On the one hand, finding the species in degraded areas indicates its adaptability to habitat alteration. The tolerance limits of this adaptability remain to be determined. It is, however, doubted that the species can cope with the fast and continuous habitat destruction, mainly caused by slash and burn farming practices (*Kaingin*). In addition, the species was found to be heavily exploited for local consumption in Roxas (this study; Acosta, 2006; Schoppe and Matillano, 2008; Matillano, 2008). In their search for the species, hunters destroy the river bed and resting habitats to harvest an entire group of individuals. The species is one of the key conservation species in Palawan (Anda and Tabangay-Baldera, 2004) and is also exploited for the international pet trade. It is available on Asian, European and American pet markets (P.P. van Dijk, in litt., May 2004; C. R. Shepherd, in litt., July 2004). And especially after its rediscovery in 2004, prices were extremely high. In Germany it gained an equivalent of USD 2,486 per individual (Richard Gemel, Natural History Museum, Vienna as cited by Uwe Fritz, Staatliches Museum für Tierkunde, Dresden, Germany, pers. com. 2004). A quick browse on the Internet by Diesmos et al. (2004b) showed that at least five sites were openly selling the species with each individual commanding a price of up to USD 1,360. A pet shop survey in Japan in 2007 found the species in two of 40 shops where it was sold for USD 1,624 (M. Auliya, Traffic Southeast Asia, in litt. to SS., April 28, 2008).

Prior to our sightings of wild specimens in January 2004 that were published in a different context already in 2004 in German (Widmann et al., 2004), the species was first reported from Palawan by Timmerman and Auth (1988) who had purchased one individual from Taytay. Only in 2001, 15 years later, Diesmos et al. (2004a) had encountered the species again in markets or public places in Brookes Point, Rizal, Aborlan, Puerto Princesa City, and Taytay, and later in 2003 also in the wild in Taytay (Lake Manguao), and Dumaran Island. This led to the conclusion that the species is endemic to Palawan (Diesmos et al., 2004b) and later to its assignment to the genus *Siebenrockiella* (Diesmos et al., 2005). Recent surveys in the south of the province could not confirm the occurrence of the species south of Puerto Princesa City (Matillano, 2008; Pierre Fidenci, Endangered Species International, pers. comm. to SS 14 January 2008), we therefore believe that the species is restricted to the central and northern Palawan only, despite claims to the contrary (Fidenci, 2007).

The above mentioned threats in combination with its limited range constitute a serious problem to the survival of the species. The fact that the species is locally protected under the Philippine Wildlife Act (Republic of the Philippines,

2001), a law that regulates the collection and possession of all wildlife species and their by-products does not assist in the conservation of the species, due to the weak implementation of the law in the Philippines. Similarly, its listing under Appendix II of CITES to regulate international trade (CITES, 2007), and the general trade ban of all wild caught animals in the Philippines do not significantly hinder its export to Europe, the US and Japan.

Southeast Asian Box Turtle - *Cuora amboinensis* (Daudin, 1802)

The Southeast Asian Box Turtle, locally known as *Ba-o, Pagong* or *Bakoko*, is classified as Vulnerable by IUCN (2007). The species is still relatively common in Palawan, and was encountered in all, except two, of the survey sites. The species inhabits natural and man-made wetlands, such as marshes, swamps, rice fields, drainage canals and other standing freshwater bodies. It was absent in Lagan, a mangrove site, and in Ilian, as sampling was restricted to VES along the river and its banks. A total of 57 individuals comprising 0 hatchlings, 24 juveniles, 22 female and 11 male were encountered. Juveniles ranged in MeCL from 62.6–100.5 mm and weighed between 38.0–150 g. Females measured between 103.5 and 169 mm in MeCL, and weighed between 155 and 850 g. Males had MeCL between 102.0–168 mm and ranged in BW from 190–680 g.

In the study area, as well as in the rest of Palawan, the species faces several threats: destruction of natural wetlands, prosecution as pest in rice fields, pollution of water bodies with waste waters, solid wastes and insecticides, collection for local consumption as food and traditional medicine, and collection for the international food and traditional Chinese medicine (TCM) market.

The species is widely distributed over southeast Asia. Four subspecies are recognized: the Wallacean Box Turtle *C. amboinensis amboinensis*, the Malayan Box Turtle *C. a. kamaroma*, the Indonesian Box Turtle *C. a. couro*, and the Myanmar Box Turtle *C. a. lineata* (Rummler and Fritz, 1991; McCord and Philippen, 1998). Of these, the first two subspecies are recorded for the Philippines. *Cuora a. kamaroma* is known from Tawi-tawi, the Sulu Archipelago (Gaulke, 1995a; 1995b) and the Palawan group of islands (Diesmos et al., 2008), while *C. a. amboinensis* is widespread in the Philippines archipelago (Alcala, 1986; Gaulke and Fritz, 1998; Nietzke, 1998). Morphometrics of individuals collected during the present study and of those encountered by one of us (SS) at other sites in Palawan reveal morphological differences in individuals from the Palawan population from *C. a. kamaroma* encountered in Borneo and Peninsular Malaysia. The first author (SS), therefore, believes that the population in Palawan constitutes an undescribed subspecies of *C. amboinensis* (Schoppe, in prep.).

Near threatened species

Variable-backed Frog - *Rana moellendorffi* Boettger, 1893

This species is classified "Near Threatened" (IUCN, 2007). The present survey found it abundant at sites where it occurs. We assume that an IUCN status assessment might lead to the downgrading of the species. It was absent in all three sites of the municipality of Dumaran, but present in Binaluan, Kemdeng and Roxas. We found it on riparian vegetation and rocks along the stream banks. It becomes active and males call with the onset of dusk. The six voucher specimens were all adults that ranged in SVL from 34.6–52.0 mm and BW from 3.5–11.5 g.

The species is endemic to the Palawan group of islands (Diesmos et al., 2004f). At the survey sites, habitat destruction was identified as the major threat. In their IUCN assessments, Diesmos et al. (2004f) listed loss of lowland rainforest due to forest clearance, and pollution of mountain streams and rivers, especially due to agricultural effluents, as potential threats.

Asian Leaf Turtle – *Cyclemys dentata* (Gray, 1831)

The Asian Leaf Turtle, locally known as *Kuritan, Bayu-o*, *Pagong* or *Bakoko*, is classified Low Risk/Near Threatened by the IUCN (2007). The species was encountered in all, except the mangrove site in Lagan, Dumaran Island. *Cyclemys dentata* was found common in shaded portions of shallow slow flowing lowland and mountain streams. The species is nocturnal, and during the day, individuals were found hiding in or near the stream-bed, under

vegetation, logs or rocks. At night, they forage in the stream. A total of 71 individuals were encountered, most of them in Roxas and Dumaran, where mark-recaptures surveys of *S. leytensis* were conducted. Juveniles (n = 37) ranged in MeCL from 53.1–150 mm and BW from 22.5–570 g. Adults measured 151–190 mm MeCL and weighed 450–1110 g.

With the ongoing reduction of its natural habitat, it is more and more found also in small freshwater reservoirs or puddles near bamboo and wetland-loving trees (Schoppe, pers. obs.). In areas where *C. amboinensis, S. leytensis* and *C. dentata* occur in sympatry, it seems that, after *S. leytensis, C. dentata* is second in demand for subsistence consumption. All over its range in Palawan, the species is collected for the international trade, and individuals leave Palawan illegally. Of major concern to the survival of the species are ongoing habitat destruction such as deforestation, sedimentation and pollution of streams.

The distribution of the Asian Leaf Turtle includes the southern Malay Peninsula, the islands of the Greater Sundas and the Philippines (Fritz et al., 2008). In the Philippines, the species is restricted to the Palawan and the Tawi-tawi group of islands (Gaulke and Fritz, 1998; Diesmos et al., 2008).

Conclusion and recommendations

The ongoing habitat destruction especially in Palawan's lowland forests constitutes a serious threat to its herpetological fauna. Authorities seem incapable of regulating slash-and-burn farming practices in low elevations nor restricting it in higher elevations. The best and possibly only way to protect Palawan's herpetofauna is through habitat and site-based actions such as the establishment or the maintenance of protected areas in combination with communication and education. One immediate result of the surveys was the declaration of the forest patch on Dumaran Island habitat of the critically endangered Philippine Cockatoo and Philippine Forest Turtle, as protected area under municipal resolution.

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APPENDIX I

Amphibian and reptile species recorded from the survey sites within the Pagdanan Range, Palawan, Philippines. Abbreviations: C = caught; O = observed; S = secondary information.

Species	Binaluan, Taytay	Kemdeng, San Vicente	Roxas	Ilian, Dumaran mainland	Sto. Tomas, Dumaran Is.	Lagan, Dumaran Is.
Amphibians						
Barbourula busuangensis	C	C				
Bufo philippinicus	C	C	O	O	C	C
Chaperina fusca	C				C	
Leptobrachium cf. hasseltii		C				
Limnonectes acanthi	C	C	O			
Megophrys ligayae	C		O		C	
Occidozyga laevis		C	O		C	
Polypedates leucomystax			O			
Polypedates macrotis	C					
Rana moellendorffi	C	C	O			
Rana sanguinea	C	C	O	O	C	
Staurois natator	C	C	O	O		
Snakes						
Ahaetulla prasina	O					
Boiga dendrophila multicincta	O	O			O	O
Boiga schultzei	C	C				
Broghammerus reticulatus			O			
Chrysopelea paradisi				O		
Dendrelaphis sp.	O	O	O			O
Gonyosoma oxycephalum					O	
Lycodon subcinctus sealei		C				
Naja sumatrana			O			
Opisthotropis typicus		C				
Rhabdophis chrysargos		C		O		
Sibynophis bivittatus					C	
Trimeresurus schultzei		C				
Ramphotyphlops braminus		C				
Lizards						
Bronchocela cristatella	C		O		C	
Draco palavanensis	O	O		O		
Emoia atrocostata	O			O		O
Eutropis indeprensa	C					
Eutropis multifasciata	C	C	O	O	C	O
Gehyra mutilata		O		O		
Gekko athymus		C				
Gekko gecko	O	O		O	O	O
Gekko palawanensis				O		
Hemidactylus frenatus	O	O		O		O
Varanus marmoratus	O	O	C	O	C	O
Unid. gekkonid sp. 1		O				
Unid. scincid sp. 1		O				
Crocodiles						
Crocodylus porosus						S
Turtles						
Cyclemys dentata	C	C	C	C	C	
Cuora amboinensis	C	C	C		C	
Siebenrockiella leytensis		C	C		C	

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On the second specimen of *Opisthotropis rugosus* (van Lidth de Jeude, 1890) (Colubridae, Natricinae)

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(with two text-figures)

ABSTRACT.– ***Opistothropis rugosus* (van Lith de Jeude, 1890), hitherto known from the unique holotype, is here reported after over a century, ca. 200 km north-west of the type locality. This specimen is similar to *O. typicus* (Mocquard, 1890) (type locality: Gunung Kinabalu, Sabah, Malaysia). Additional specimens of *O. typicus*, reported for the first time from Kalimantan Tengah (Borneo), south of the equator, is reported here.**

Introduction

The genus *Opisthotropis* consist of about 17 species, and has a wide distribution in south-east Asia, with only the type species supposedly from Africa (Orlov et al., 1998). All species are known from only a few specimens, making it one of the least known group of snake in south-east Asia. About seven genera that have been proposed before Smith (1943) are currently in the synonymy of *Opisthotropis* Günther (1872). The Malay Archipelago has two species: *O. rugosus* (van Lidth de Jeude, 1890) from Sumatra Barat, Indonesia and *O. typicus* (Mocquard, 1890) from Sabah, Brunei, Sarawak, and Palawan in the Philippines. The Sumatran species, *O. rugosus* was described 118 years ago, and no new information has been published subsequently. The data presented on these species in David and Vogel (1998) and Iskandar and Colijn (2000) are essentially all that is known.

In September 2006, during an expedition to Batang Toru, Sumatra Utara Province, a second specimen of *O. rugosus* was acquired ca. 200 km north-west of the type locality. It was found freshly dead in the field, preserved in 10% buffered formalin, and later transferred to 70% ethanol. On a separate expedition in May 2008 to Kalimantan Tengah Province, we collected a juvenile *O. typicus,* which was found actively foraging in a slow moving stream at a heavily disturbed primary rainforest, euthanized with oral application of lidocaine and preserved as in the previous specimen. It represents the first record of the species from the Indonesian part of Borneo. The finding of these new specimens expanded our knowledge of the natural history of two members of the genus.

Comparison has been made to the original description and *O. typicus* from Kalimatan Tengah and another specimen recently acquired from Palawan. The specimens of this study were deposited in the Museum Zoologicum Bogoriense (MZB), Cibinong, LIPI, Bogor, Indonesia (see Appendix I). Measurements were made after preservation to the nearest mm. Data on the type specimen were taken from the original description and from de Rooij (1917).

Observations and discussion

A medium-sized species, with SVL up to 430 mm; TL up to 130 mm or 30–38% of SVL; BSc 17 at midbody; ventrals 170–174; subcaudals 76–84; head not clearly distinct from neck and body; tail moderate; eye small; pupil round; nostril directed dorsally, pierced in the middle of the nasal, nostril partly or entirely divide the nasal scale, two internasals narrowed anteriorly, separated from each other or forming a suture behind rostral; rostral wider than high or as high as wide, slightly visible from above, with a deep

notch below; one pair of prefrontals, slightly broader than long; frontal about as broad as long, equal to its distance from the snout tip, shorter than the length of the suture of the parietals, about half length of parietals; one large and long loreal; a single preocular; one or two postoculars, the upper largest; 12–13 supralabials, 4th to 11th (8–12th in the type) divided at the lower part close to the mouth, 6–7 or 7–8 below the eye, prevented from touching the eye by three suboculars; 1+1 or 1+2 temporals; 10–11 infralabials, first four or five touching first pairs of chin shields, other infralabials are narrower and separated from second pairs of chin shields by one row of elongated scales; second pair of chin shields separated from each other by an elongated scale or a row of small scales; body scales in 19:17:15 rows, body scales strongly keeled and raised centrally, keel forming continuous line from behind head to tail; tail scales strongly keeled, eight longitudinal keel rows at base of tail, reducing to four rows distally; subcaudals paired or partly undivided.

Colour.– In life, eye is black; body above purplish-brown to dirty black, sides brown with no particular markings (Fig. 1). In preservative, purplish-brown fading to dark brown; venter cream, dark speckling on labials especially along the border of scales, outer margin of ventrals dark brown in specimen from Kalimantan, uniform in the specimen from Sumatra.

Ecology.– The specimen was found dead in a slow to moderate flowing stream. The habitat was similar to the ecological condition for *O. typicus* which is typically underwater beneath rocks and in rock crevices (Orlov et al., 1998; Stuart, 2006). This specimen and the holotype were collected at low altitudes. Aek Nangali is ca. 600 m asl, and Kayu Tanam is < 300 m asl. *O. typicus* was reported from lowlands as well in Borneo (Das, 1995; Stuebing and Inger, 1999). The specimen from Kalimantan was collected at ca. 100 m asl, crawling and swimming at the side of a shallow and slow moving stream. Other mainland species have been reported from fast-flowing mountain streams (Orlov et al., 1998; Stuart, 2006).

Distribution.– This species was first found at Kayu Tanam (00°32–33'S, 100°19–20'E, ca. 300 m asl), Province Sumatra Barat, which is ca. 200 km to the north-west where the second specimen was found. It is the sole specimen known to date before we found the second specimen in North Sumatra, 118 years later.

Comparisons.– Compared to *O. typicus*, we find that colouration and pholidosis details are strikingly similar as practically all characteristics were found to be overlapping (Table 1). The only consistent differences between the Sumatran and Bornean population is the number of scale rows, 17 in Sumatran specimens and 19 in the Bornean and Palawan populations, based on our small sample. The similarities between both forms have been recognized previously (Boulenger, 1891; Mocquard, 1892). Even Mocquard already discussed the priority of *O. typicus* over *O. rugosus*. As both forms are only known at that time from the holotypes, no comments on their systematic status were made. The specimen from Palawan shows a single prefrontal and partly divided subcaudals, this last variation is also recorded in the northern Sumatran specimen of *O. rugosus*. The specimen from Kalimantan Tengah is distinct in having a low number of ventral scales and a relatively long tail (41% vs. 28–32%) and entire anal (Table 1), also recorded previously. It thus appears to be a

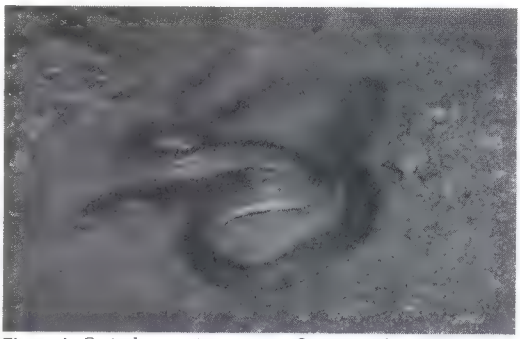

Figure 1. *Opisthotropis rugosus* from northern Sumatra.

Figure 2. *Opisthotropis typicus* from central Kalimantan.

matter of choice whether the Kalimantan Tengah specimen represent a distinct species or not. The three characteristics mentioned above place this specimen more distantly to both *O. typicus* and *O. rugosus*. As all these variations were reported previously (Manthey and Grossmann, 1997; Stuebing and Inger, 1999), we prefer to adopt a conservative view that the Kalimantan Tengah specimen belongs to *O. typicus*, even contradicted with our conclusion in retaining the more closely related forms *O. typicus* and *O. rugosus* as distinct. Unfortunately tissue for DNA comparison is at present only available for the Kalimantan Tengah specimen. Number of specimens available does not permit a conclusion regarding their systematic status. With only a single specimen at hand and knowing that its characteristics were mentioned in literature, the Kalimantan Tengah specimen is at present identified as *O. typicus*.

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We thank Frank Tillack and Ulrich Kuch (Germany) for providing information on the original publication of Th. W. van Lidth de Jeude and R. Mocquard. Van Wallach (USA) and P. David (Paris) supplied literature and also useful comments on the manuscript. We thank the generosity of A. Diesmos (the Philippines) in sharing data on the Palawan specimen during the visit of the first author to Singapore. This work has been done with the generous support from the Sumatran Orang Utan Foundation to the second author. The work in Central Kalimantan was sponsored by Daemeter Consultant to the first author. We thank our institution for laboratory

Table 1. Meristic data of three specimens of *Opisthotropis rugosus* compared with those of *O. typicus* collected from three separate localities.

Locality	O. rugosus		O. typicus		
	North Sumatra	West Sumatra	Kalimantan Tengah	Palawan	Kinabalu
	MZB 3791 (MK 452a)	(holotype)	MZB 3792 (KR 397)	PNM (RMB 3111)	(holotype)
SVL (mm)	433	343	305	475	295
TL (mm)	131	130	125	134	95
Total (mm)	564	473	430	609	390
Nasal	divided	divided	divided	divided	divided in contact
Loreal	1	1	1	1	1
Prefrontal	1/1	1/1	1/1	1 (undivided)	1/1(1)
Preocular	1	1	1	2	2
Postocular	2	1	1	1	2
Temporals	1+	1+2	1+2/1+1	1+2	1+1+2
Subocular	3/3	3/3	4/4	5/5	3/3
supralabials (below eye)	13/13 (6–7/7–8) 4–11 divided at lower part	12/12 (?/?) 8–12 divided at lower part	12/12 (7–8/8–9) 4–11 divided at lower part	11/11	11/11 (7–8) 3–10 divided
infralabials	11/11	10/10	9/9	8/8	-/-
Anal shield	divided	divided	single	divided	divided
Subcaudals	2/2+3+79/79 = 84/84	76–85?	87/87	5/5+4+6/ 6+1+2/ 2+1+63/63 = 82/82	95/95
BSc at midbody	17	17	19	19	19
Ventrals	174 umbilical scar 155–158	170	155 umbilical scar 140–141	181	176–184?
Internasal	2	2	2	2	2

facilities. First author's visit to Singapore was supported by the Biodiversity Grant from Ministry of Education, Singapore no #R-154-000-270-11 2.

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APPENDIX I

Opisthotropis rugosus (van Lidth de Jeude, "1891" 1890). MZB.Oph.3791 (field number MK 452a), an adult male, from Aek Nangali (0°37'32"N; 99°26'27"E at 600 m asl), Village Batang Natal, Kecamatan Mandailing Natal, Kabupaten Tapanuli Selatan, Province Sumatra Utara, by M. Kamsi, 15 September 2006.

Opisthotropis typicus (Mocquard, 1890). MZB. Oph.3792 (field number KR 397), a young female from a small tributary of Sungei Beriwit (00°21.569'S; 114°50.981'E at 108 m asl), part of the Sungei Barito Basin, central Kalimantan, by D. T. Iskandar, 20 May 2008. PNM (field number: RMB 3111) from Palawan, the Philippines.

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On the distress call and threat call of *Ptychozoon kuhli*

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(with six text-figures)

ABSTRACT.– **Two different call types of *Ptychozoon kuhli* were recorded – a female distress call and a male threat call, but no advertisement calls were observed. Call structures, their lengths, sound intensities, and frequency ranges were analysed. The function of both calls and the relationship between maximum sound intensity and call frequency is discussed. Parts of the associated behaviours are described. The calls are presented in oscillo-and audiospectrograms, as well as three-dimensional images.**

KEY WORDS.– **Reptilia: Sauria: Gekkonidae: *Ptychozoon kuhli*, acoustic behaviour, distress call, threat call.**

Introduction

Pioneering works on bioacoustic behaviour in geckos were published by Haacke (1968, 1969), who studied the calls of the barking geckos, *Ptenopus garrulus* and *P. kochi*. Soon after, a number of publications, mainly by Frankenberg (1973, 1974, 1975, 1978) and Marcellini (1974, 1977a, 1977b), brought insight to acoustic communication in the genera *Cyrtopodion*, *Hemidactylus* and *Ptyodactylus*. Recent works have analysed various aspects of the calls of the gecko genera *Hemidactylus* (Gramentz, 2007: as *Cosymbotus*- see Zug et al., 2007), *Gekko* (Tang et al., 2001), *Haemodracon* (Gramentz, 2005c), *Homopholis* (Gramentz, 2009), *Pachydactylus* (Gramentz and Barts, 2004), *Stenodactylus* (Gramentz, 2004), *Tarentola* (Gramentz, 2005b) and *Thecadactylus* (Gramentz, 2007b) to mention but a few.

That *Ptychozoon kuhli* possesses a voice has been mentioned in the literature. According to Manthey and Grossmann (1997), males are capable of producing calls whose function is to communicate with females. This is apparently part of the species reproductive behaviour. Its close relative, *P. lionotum,* also possesses a voice and call is part of antipredator behaviour. Zimmermann (1980) observed that at first, it threatens by opening the mouth and sometimes produces a croaking sound; if individuals continue to feel threatened, reacts by biting.

Material and Methods

Two adult males and one female of *Ptychozoon kuhli* were bought from a reptile dealer in April 2007. The geckos were kept separately in containers measuring 33 x 40 x 65 cm. For sound insolation and avoidance of reflections, the side walls were made of wood and covered with cork on the inside. One male died after about three months, without previously showing any behavioural or external signs of discomfort or illness. After a time period of about five months, the female was placed into the container of the remaining male in October 2007 and the distress calls were recorded and digitized. The snout-vent length in both geckos was ca. 85 mm. The threat calls were recorded in January 2008.

The recording equipment has been described by Gramentz (2005a, 2005b). Creative Soundblaster Audigy 2 ZS Platinum Pro sound card, with a sample rate of 44100 Hz, 16 bit, was used. Analysis was performed using Avisoft-SASLab, Creative WaveStudio and Raven1.2. The Product Moment Correlation Coefficient function was used.

Three distress calls of the male and female and twenty two threat calls of the male were re-

corded. Two of the distress calls and 19 threat calls could be used for analysis. During the distress call recordings, the distance between the microphone and the geckos varied from ca. 10–30 cm. The microphone was used to stimulate a threat call by moving it slowly towards the gecko. A call was usually emitted at a distance of about 1–2 cm between gecko and (head of) microphone. The air temperatures during the recordings were 24.6–26.1° C.

Results

At least of two different calls – a distress call and a threat call, were recorded in *Ptychozoon kuhli*. The distress call is a very short snare-like sound and the threat call is expressed as a short spitting sound.

Distress call.– Both distress calls were emitted by the female at tactile contact with the male, however, due to the speed of action and the dim light conditions, the exact behaviour prior to the calls could not be discerned.

The two analysed distress calls had a length of 0.151 sec and 0.201 sec, respectively. Maximum frequency in the shorter call was 13101 Hz and in the longer call, was 13009 Hz. Similarly, minimum frequencies in the two calls were also rather close, 277 Hz in the shorter call and 349 Hz in the longer one. Maximum sound intensity was 77.2 dB at 2306 Hz in the shorter call and 69.3 dB at 3229 Hz in the longer call. The values for maximum sound intensity lasted only for 0.002 and 0.003 sec.

The distress call is formed by a number of indistinct pulses (Fig. 1a–1b). They are a bit more clear in Fig. 2b, but too rough for measurements. The two calls are unequal in the position of greatest strength. In one call, the greatest strength is located in the middle part (Fig. 1a and 2a) while in the other, it is at its end (Fig. 1b and 2b). No harmonics could be identified in this type of call.

Threat call.– The threat call had no uniform structure, but three distinct parts can be recognized, although their boundaries are indistinct. A threat call stands at the end of other behaviour, signalling tension and a threatening display.

Before a threat call is produced, the gecko starts to move its tail in slow twisting movements from side to side when a potential predator has approached ca. 20–25 cm. At a distance of ca. 10–12 cm, the gecko may open its mouth either slightly or in a wide gape. Only at a dis-

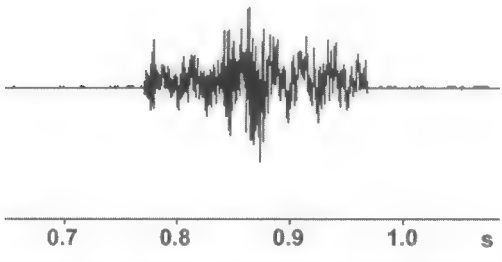

Figure 1a. Oscillogram of a distress call of a female of *Ptychozoon kuhli* with a length of 0.201 sec.

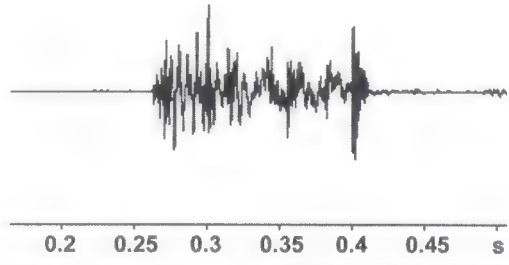

Figure 1b. Oscillogram of a distress call of a female of *Ptychozoon kuhli* with a length of 0.151 sec.

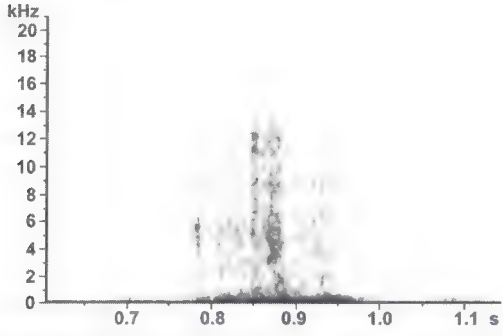

Figure 2a. Audiospectrogram of the distress call in Fig. 1a.

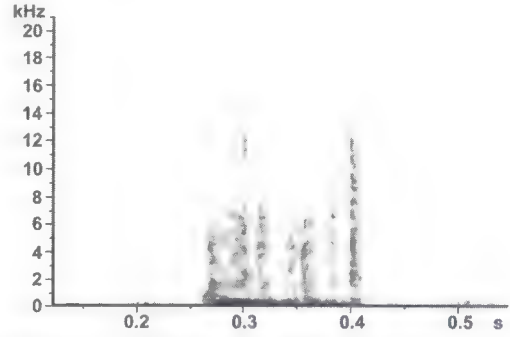

Figure 2b. Audiospectrogram of the distress call in Fig. 1b.

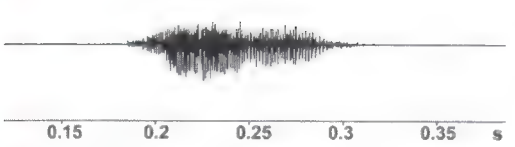

Figure 3a. Oscillogram of a threat call of a male of *Ptychozoon kuhli* with a length of 0.127 sec.

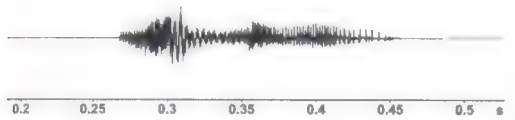

Figure 3b. Oscillogram of a threat call of a male of *Ptychozoon kuhli* with a length of 0.186 sec.

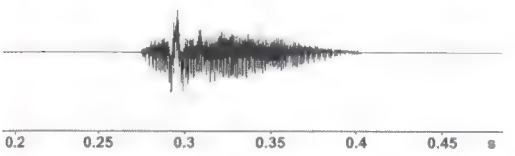

Figure 3c. Oscillogram of a threat call of a male of *Ptychozoon kuhli* with a length of 0.125 sec.

tance of 1–2 cm from a potential predator, a single threat call is emitted. The call can be accompanied by a feint attack by thrusting its head forward in a dash-like movement but without actually biting. Immediately after a call, the gecko makes evasive movements away from the potential predator.

As can be seen in the oscillograms in Figs. 3a–3c, the intensity of a threat call increases rather steadily from the beginning of a call up to a peak situated in the anterior third or quarter of the call. After this peak showing the strongest amplitudes it decreases more or less continuously forming a short tail characterized by a few weak amplitudes. The length of the threat call varied between 0.103 sec and 0.186 sec, with an average of 0.136 sec (SD = 0.02, n = 19).

The maximum frequencies showed rather little variation. They ranged from 17898–19282 Hz. Average maximum frequency of threat calls was 18607 Hz (SD = 556.07, n = 19). All threat calls had low frequencies - below 85 Hz - and frequency below that point could not be determined precisely.

The average frequency at which maximum sound intensity was reached was 2207 Hz (SD = 2616. 9). The range in this respect varied considerably between 89–6,550 Hz. There was

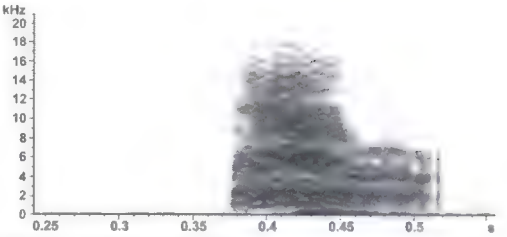

Figure 4a. Audiospectrogram of a threat call of a male of *Ptychozoon kuhli* with a length of 0.142 sec.

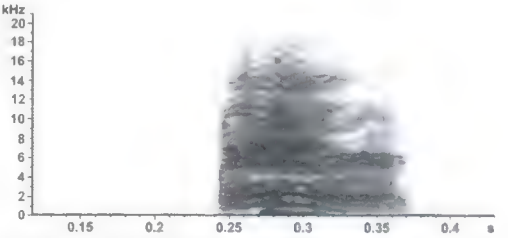

Figure 4b. Audiospectrogram of a threat call of a male of *Ptychozoon kuhli* with a length of 0.129 sec.

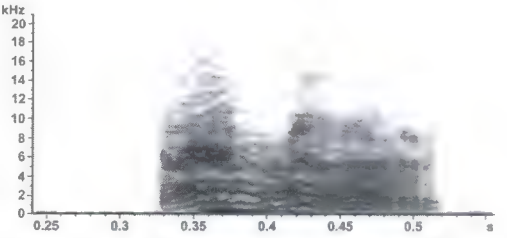

Figure 4c. Audiospectrogram of the threat call in Fig. 6.

a statistically strong negative correlation (r = -0.74, $P < 0.001$) between the maximum sound intensity of a call and the frequency at which maximum sound intensity was produced (Fig. 6). The call with the highest sound intensity reached this at only 92 Hz, and the five calls showing the highest sound intensities reached this between 92 and 185 Hz. On the contrary, the lowest maximum sound intensity in a threat call was 91.5 dB and this was measured at 6610 Hz.

The threat call of *P. kuhli* has a strong sound intensity. The measured maximum sound intensity was 113.1 dB. Of the 19 calls examined, 12 (63%) reached sound intensities above 100 dB, and three calls (16%) were above 110 dB. Average maximum sound intensity was 102.9 dB (SD = 5.57, n = 19).

Harmonics were discernable in all the examined threat calls, usually not for the whole duration but for the major part of a call. The intervals between harmonics were found to differ in the

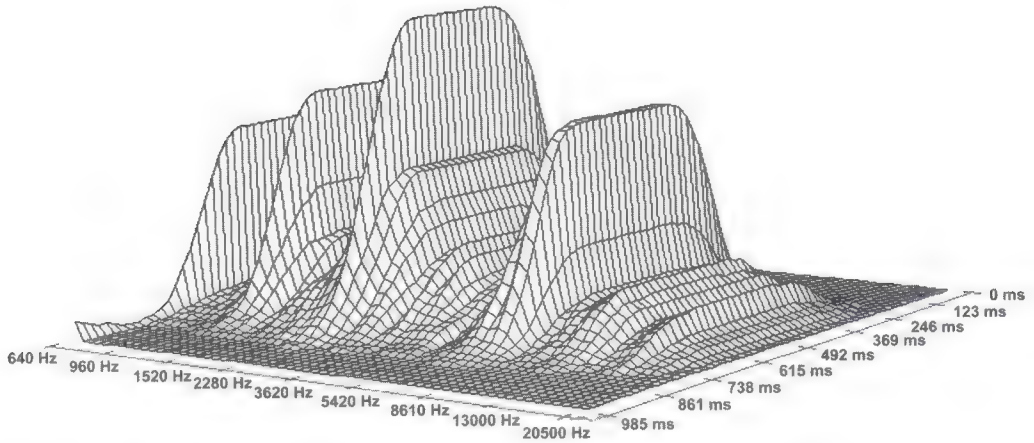

Figure 5a. Three-dimensional logarithmic image of a threat call of a male of *Ptychozoon kuhli* with a length of 0.124 sec.

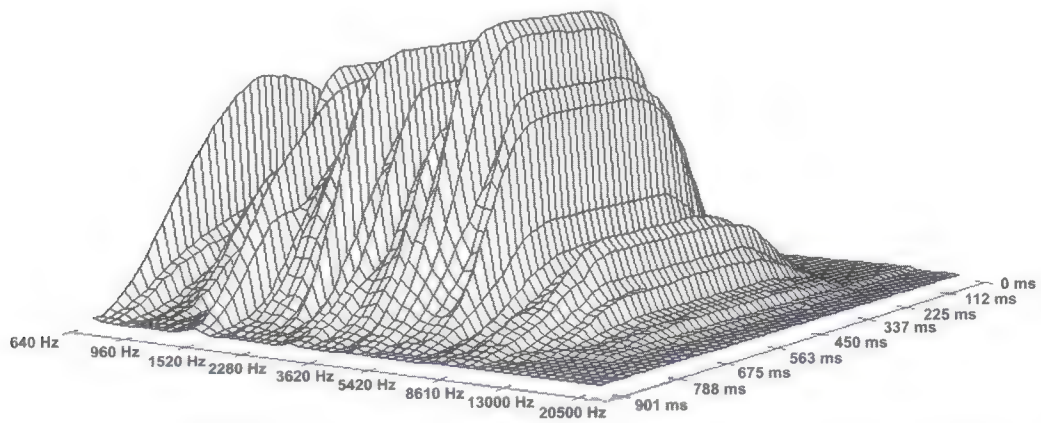

Figure 5b. Three-dimensional logarithmic image of a threat call of a male of *Ptychozoon kuhli* with a length of 0.137 sec.

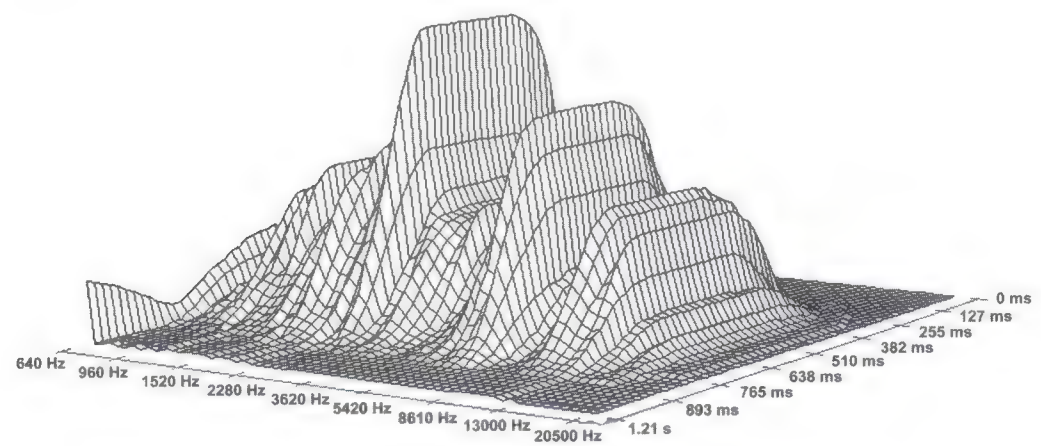

Figure 5c. Three-dimensional logarithmic image of the threat call in Fig. 5.

anterior and posterior section of a call. The average distance between harmonics in the anterior section of a threat call was 1027 Hz (SD = 161.79, n = 22), while it was 569 Hz in the posterior section (SD = 64.41, n = 30). In fact, the difference in anterior and posterior section gaps between harmonics is statistically significant ($P < 0.05$, $t = 2.2$, t-test).

Discussion

Ptychozoon kuhli appears to have no advertisement call. Some gecko species are known to advertise in the absence of females, including *Thecadactylus rapicauda* (Gramentz, 2007), *Hemidactylus mabouia* (Gramentz, 2003, Regalado, 2003), *H. platycephalus* (Gramentz, 2005a), *H. turcicus* (Marcellini, 1977a, Frankenberg, 1982) and *Gekko gecko* (Gramentz, in press), and this type of territorial call is known from other genera such as *Phyllodactylus* (Marcellini 1977b), *Ptenopus* (Haacke, 1968, 1969; Gramentz, 2008), *Ptyodactylus* (Frankenberg 1973, 1974) and *Tarentola* (Nettmann and Rykena, 1985). However, despite the five months isolation of the male geckos and during the time, when a male and a female were kept together, this type of call was not heard or recorded.

Like the distress calls of other gecko species described in the literature, the call of *Ptychozoon kuhli* consists of one syllable. This type of call is generally of short duration, but its length varies between species. Short distress calls have been recorded in *Haemodracon riebecki* with an average length of 0.069 sec (range 0.046–0.080, Gramentz, 2005c) and *Stenodactylus stenurus* having an average of 0.034 sec (range 0.033–0.036 sec, Gramentz, 2004). However, in the latter species, three types of distress calls were recorded, and the longest had an average length of 0.129 sec (range 0.111–0.143 sec). The average length of *P. kuhli* distress calls was 0.176 sec which is slightly longer. In *Thecadactylus rapicauda,* an average call length of 0.235 sec was recorded (range 0.091–0.360 sec, Gramentz, 2007) which is slightly longer than in *P. kuhli*. With few known exceptions, distress calls of gecko species studied to date frequently have lengths of $^{1}/_{10}$ to $^{3}/_{10}$ of a second. Male *Hemidactylus angulatus* were, however, recorded to have an average distress call length of 0.454 sec (range 0.224–0.955 sec, Gramentz, 2005d).

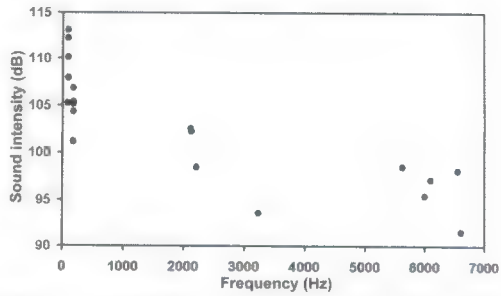

Figure 6. Correlation between maximum sound intensity of threat calls of *Ptychozoon kuhli* and the frequencies at which maximum sound intensity was produced.

In this context, the distress calls of *P. kuhli* are rather intermediate in length, compared to other gecko species.

According to Frankenberg (1975), distress calls have an antipredator function, beside an intraspecific application, and is also the case in threat calls. This is also solidified by a much greater sound intensity of the threat call than in distress call. A greater sound intensity during a call is probably more likely to deter a potential predator than a weaker one. This type of call is unknown in many gecko species. The threat call of *P. kuhli* is rather short in comparison to threat calls from other gecko species. In *Homopholis fasciata* for example, a threat call during a male-male interaction has an average length of 1.672 sec (range 0.999–2.750 sec) (Gramentz, 2009) and in *Tarentola chazaliae*, an average length of 1.844 sec (range 1.411–2.863 sec) was recorded (Gramentz, 2005b). Possibly, this type of call is also produced by *Tarentola delalandii* described as a "scream" (Schrei) by Nettmann and Rykena (1985) which lasted up to 2.65 sec. However, in comparison to the other gecko species mentioned, the average length of 0.136 sec (range 0.103–0.186 sec) of the threat call in *P. kuhli* is surprisingly short. While in *P. kuhli,* the maximum sound intensities were reached at low frequencies, usually below 200 Hz (average 2207 Hz), in *H. fasciata,* the average was 6532 Hz at maximum sound intensity, in *T. chazaliae,* the average was 4806 Hz and in *Gekko gecko,* the average was 3492 Hz (Gramentz, in press).

The maximum sound intensity of the threat calls of *T. chazaliae*, *G. gecko* (Gramentz, in press) and *P. kuhli* were remarkably similar. *P. kuhli* reached a maximum of 113.1 dB in one

call, *G. chazaliae* reached 112.7 dB and *G. gecko* 111.0 dB while in *H. fasciata* only 88.3 dB were recorded as the maximum. The lower value in this species may be explained as the threat call was used not against a predator but in an interaction with a conspecific.

Acknowledgement

I am grateful to K. A. Baumgarten (Animal-Paradies) for providing the geckos.

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A herpetofaunal inventory of Barail Wildlife Sanctuary and adjacent regions, Assam, north-eastern India

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(with two text-figures)

ABSTRACT.– **An inventory of amphibian and reptiles from the Barail Wildlife Sanctuary and its surroundings, Cachar District, Assam, north-eastern India is presented here. A total of 23 species of amphibians and 45 species of reptiles have been recorded from the study area. The observations include new locality records and natural history information of poorly known species such as *Tropidophorus assamensis* and *Eutropis quadricarinata*. Besides recording members of currently recognized species complex, the study also documents few species that were either conferred to closely related species (e.g., *Calotes* cf. *irawadi*) or their species identity remain to be ascertained (e.g., *Rhabdophis* sp. and *Amolops* sp.). The sharp slope in the species accumulation curve from the present study indicates that species count will rise further with additional surveys.**

KEYWORDS.– **Herpetofauna, Barail Wildlife Sanctuary, north-east India, inventory, new locality records.**

Introduction

Barail Hill Range lies in North Cachar Hill District, and is the south-western extension of the Patkai Range, and runs in a south-westerly direction from southern Nagaland and parts of northern Manipur, up to the Jaintia Hill of Meghalaya (Fig. 1). The higher elevation (1,500–2,500 m) areas of the Range is located in southern Nagaland state, while low to mid-elevation areas are in the North Cachar and Cachar Districts, continuing up to the Jaintia hills of Meghalaya.

Barail Wildlife Sanctuary (BWS, 24°58'–25°05′N, 92°46'–52′E) spreads over an area of 326 sq km. This sanctuary mainly covers the low to mid elevation hills (< 30–1,100 m) of Cachar District of southern Assam. These low hill ranges are continuous with the more lofty mountainous parts of North Cachar Reserve Forest and continuous with Barail Hill Ranges in the North Cachar Hills District. The sanctuary area is drained by a network of small perennial or seasonal streams that flow through small ravines and valleys, and join Jatinga River at the western boundary of the Sanctuary. The River Dolu runs through the eastern boundary of the Sanctuary. The Silchar-Haflong railway track and the Silchar-Halflong road pass along the western boundary of BWS. There are many villages on the western and southern boundary of the Sanctuary. The primary vegetation is tropical semi-evergreen to moist evergreen forest, corresponding to Cachar Tropical Evergreen Forest 1B/C3 and Cachar Tropical Semi-evergreen Forest 2B/C2 (Champion and Seth, 1968). The main secondary landscape elements are cultivated flatlands, secondary bamboo forest, plantations (*Tectona grandis*, betel vine plan-

tations and Pan Jhum), and village gardens. The climate of the study area is largely tropical tending toward little subtropical at the upper reaches. Precipitation varies from 2000mm to 6000 mm with a brief but predictable rainless period. The westernmost part of the sanctuary receives the highest rainfall in Assam (Choudhury, 1993).

Materials and methods

Field Surveys.– From March-September 2007, one of us (AD) spent 95 field days in and around Barail Wildlife Sanctuary, to document the herpetofaunal diversity of the area.. During that period, 17 localities (Table 1), representative of all the major habitat types of the Sanctuary, were surveyed. Collections were made randomly and opportunistically. An identified survey area was walked extensively, while visually searching for amphibian and reptile species and largely focusing on prospective microhabitats. However, active searches involving turning rocks and logs, peeling bark, digging through leaf litter, and excavating burrows and termite mounds also produced excellent results. During the day, be-

Table 1. Details of survey sites in the Barail Range during present study.

Site	Coordinates	Elevation	Habitat types
Lakhicherra	24°58.651'N 92°46.754'E	~55m	Rocky fast flowing stream with riparian vegetation. Extensive growth of wild Musa clumps along stream. The lower reaches of the stream having Jhum cultivation on surrounding hills.
Chamduba	24°58.720'N 92°47.183'E	~31m	Fast flowing stream with large boulders and thick riparian growth.
Tellacherra	24°58.692'N 92°47.491'E	~85m	Large stream with steep slope on one side and gravel flat land on the other.
Maruacherra	24° 58.342'N; 92° 46. 168'E	~30m	Village fringe, surrounded by cultivated area and degraded forests.
Barkhola	24°55'51.17"N 92° 44'55.58"E	40m	Human habitation with many ponds, plantations and open fields.
Barail WLS Teak Plantation	24°58.720'N 92°47.183'E	~100m	Extensive teak plantation with thick leaf litter.
Adakuchi Basti Nullah	24°59.550'N 92°44.544'E	~173m	Rocky streambed with steep slope and thick vegetation on either side, thick accumulated plant material on stream bank.
Chotorampur	24°57.127'N, 92°46.984'E	~36m	Degraded forest with many small streams and water puddles on the edge of a tea garden.
Lakhicherra Pahar	24°59.053'N, 92°46525'E	~ 300 m	Evergreen forest with patches of bamboo clumps.
Nunchuri, Bihara	24°57.351'N, 92°39.192' E	~22m	Degraded forest with bamboo clumps through which passes large rocky Harang stream. Rock mining area.
Sibtilla, Bihara	24°57.288'N, 92°39.357'E	~19m	Ficus trees and bamboo clumps on the slope at the edge of paddy field and human habitation.
Naraincherra	24°58.041'N, 92°44.554'E	~58m	Slow-flowing stream with large gravel flat land with grass and thick bushes on sides.
Bhaluknala	24°58.856'N, 92°46.863'E	~40m	Narrow stream of Lakhicherra with dense riparian and lithophytic vegetation.
Gubicherra hill	24°59.061'N, 92°46.507'E	~200m	Fast flowing stream with large bryophyte covered rocks and extensive growth of lithophytic vegetation.
Borthol	24°58.864'N, 92°47.330'E	~45m	Fast flowing stream with large bryophyte covered rocks.
Digorkhal	24°58.030'N, 92°34.520'E	~70m	Riparian vegetation. Large boulders on stream. Rocky collection trails.
Nirmatha Hill	25°01'17.79"N, 92°48'54.03"E	~ 1100m	Well canopied forest on a > 50° slope with large buttressed trees and thick leaf litter.

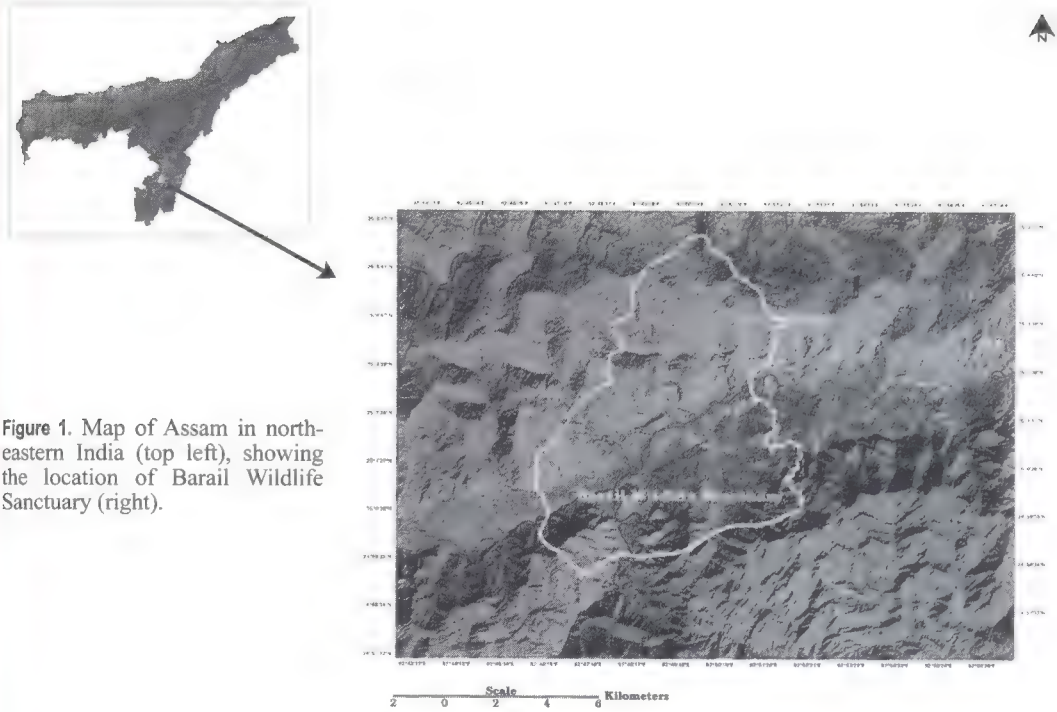

Figure 1. Map of Assam in north-eastern India (top left), showing the location of Barail Wildlife Sanctuary (right).

sides active search, heliothermic (basking) reptiles were also searched for along forest trails, forest edges and stream sides. For frogs, collections were sometimes made on the basis of calls heard along forest trail, forest edges and along streams between 1800–2200 h, aided by powerful flashlights. Aquatic search mostly involved examining watercourses, ephemeral and permanent pools, etc. Opportunistic observations of any species in the study area were also recorded. Records of road kills and animals collected or killed by neighbouring village people were also noted.

Data collection.– Locality, microhabitat, habitat, sex and reproductive data of individuals, sympatric species (if any noted) were collected. Behavioural observations were recorded in a field data sheet. Morphometric data on specimens were obtained for identification, which was supported by colour photographs taken with a Canon S3IS digital camera. Geographic coordinates for survey sites were recorded with a Garmin 12 receiver GPS. Interactions with local residents were held to make them aware of the local herpetofauna and to supplement field observations.

Species were identified using the keys of Smith (1931, 1935, 1943), Schleich and Kästle (2002), Das (1995), Dutta (1997) and David and Vogel (1996). Nomenclature and taxonomic arrangement in the text follows Frost (2009) for amphibian, and Das (2003) and Uetz (2007) for reptiles.

Abbreviations: ZSIC = Zoological Survey of India Kolkata; BMNH = The Natural History Museum, London; AMNH = American Museum of Natural History; BNHS = Bombay Natural History Society; and AD/BR = Abhijit Das/ Barail Range field series.

Species accounts

Amphibia

Anura

Dicroglossidae

1. *Euphlyctis cyanophlyctis* (Schneider, 1799)

Material: None collected.

Abundant in different types of water bodies (ponds, rivers, forest streams, temporary water pools, village water holes and wells, and also swampy areas). Individuals from different areas

of the survey sites showed variation in dorsal pattern. The Moynagarh and Abang Punjee individuals have large dark blotches on the dorsum. Individuals from Jatinga River and other forest streams of Barail, however, are without any dark blotches but have longitudinal rows of large warts on the dorsum.

2. *Fejervarya* sp. 1

With a broad cream coloured mid dorsal stripe; dorsum with long skin fold. Forelimb and hind limb barred. Recorded abundantly in plantation area, open fields, temporary water pools, degraded forest edges, around human habitation and cultivated areas.

3. *Fejervarya* sp. 2

Individuals with very narrow or no mid dorsal line; reddish patch on dorsum. Sympatric with *Fejervarya* sp. 1, it inhibits areas with moist grass near seasonal and perennial water bodies.

4. *Fejervarya* sp. 3

Relatively small body size; narrow but distinct reddish mid dorsal line. Snout more pointed than sister species. Forelimbs not barred; encountered in slow flowing rocky evergreen forest stream.

Ao et al. (2003) recorded *F. nepalensis, F. teraiensis* from Nagaland. Borthakur et al. (2007) recognized four species (*F. nepalensis, F. teraiensis, F. pierrei* and *F. syhadrensis*) from Assam and also reported widespread occurrence of these species from the Kamrup district of Assam. However, the Barail population needs further study.

5. *Hoplobatrachus tigerinus* (Daudin, 1803)

Material: None collected.

Commonly encountered inside as well on the periphery of the Sanctuary, especially in stagnant water bodies, open fields and around human habitations. Considered a delicacy, and is locally consumed by villagers and tea garden workers.

6. *Limnonectes laticeps* (Boulenger 1882)

Material: AD/BR 09–10.

Three individuals (SVL 36–42 mm) were recorded on 1 April 2007 at 0830 h from under leaf litter of a moist rocky stream bed of Puticherra nullah. Juveniles of the species are brick red in colour. When disturbed, they attempted to conceal themselves under leaf litter. In the Kamrup district of Assam, Choudhury et al. (2001) recorded the species from 80–105 m altitude, however, during this study, *L. laticeps* were recorded at ~ 36 m elevation.

7. *Occidozyga* sp.

Material: AD/BR 05–07.

Recorded on 29 March at 1100 h from Notbeng Hill. Individuals of the species (SVL 20–27 mm) were found under rocks of a streambed and in water seepage areas of moist evergreen forest. It was also recorded under bryophyte-covered rocks in Adakuchi Basti Nullah. We encountered >10 individuals.

Ranidae

8. *Amolops* sp.

Material: AD/BR 32.

An individual of SVL 58.12 mm was collected from Adakuchi Basti Nullah from under boulders near a rocky-bottomed, slow-flowing stream at 101 m altitude. When exposed, it took refuge amongst leaf litter underwater. On 27 May 2007, further individuals were encountered on large boulders of the fast-flowing Borthol Stream. During the day, they were seen hiding among vegetation growing on large stream boulders. Although similar to *Amolops gerbillus*, further studies are needed to confirm its identity.

9. *Clinotarsus alticola* (Boulenger, 1882)

Material: AD/BR 13–16, AD/BR 24 (juv.).

On 27 May at 1420 h, a few juveniles (SVL 28.05–31.19 mm) were observed on branches of overhanging vegetation, above the Duiganga stream. On 30 August, at 1100 h, two individuals (SVL 45 mm and 56.39 mm) were recorded from vegetation growing on large rocks of Bhaluknala. They released a pungent smell upon capture. Gravid female (SVL 59.25 mm) were obtained on 30 August, and at 1900 h, calling individuals were observed on rocks and vegetation near a stagnant pool along a stream.

10. *Humerana humeralis* (Boulenger, 1887)
Material: AD/BR 08.

Recorded on 2 April at 1000 h from near Lakhicherra stream. A gravid female (SVL 82.09 mm) was found under thick leaf litter accumulated on rocky stream bank, about ca. 1 m above stream. When disturbed, it jumped into the stream and took refuge among fallen leaves underwater.

Besides Myanmar and Nepal (see Schleich and Kästle, 2002), reported from Nagaland (Ao et al., 2003), Assam and Arunachal Pradesh States (Hussain et al., 2007).

11. *Hylarana leptoglossa* (Cope, 1868)
Material: AD/BR 18.

Frequently encountered along degraded forest edge and also around human habitation. One specimen was collected (SVL 56.06 mm). Vocalizations were heard throughout the study period. Individuals were encountered under vegetation in swampy areas and in roadside water puddles. One was found under a decomposed log in a secondary forest and others were observed under rotten logs near human habitation.

12. *Hylarana tytleri* Theobald, 1868
Material: AD/BR 31.

Recorded on 2 May 2007 at 1830 h from Bihara. Individuals were seen calling from water hyacinth (*Eichhornia crassipes*) and other emergent aquatic vegetations of perennial lentic waterbodies. Three individuals were also observed in waterlogged paddy fields. Calling aggregations were also recorded from Narainchera and Barkhola localities of the study area. Choudhury et al. (2001) reported the species (as *Hylarana taipehensis*) as being abundant in Kamrup District, Assam, although Dey and Gupta (1999) noted it to be rare in Barak Valley, southern Assam. Ohler and Mallick (2002) reported that *H. taipehensis* is an inhabitant of the Indo-Chinese region and listed West Bengal, Orissa, Uttar Pradesh, north-eastern India, Bangladesh and Nepal in the distribution range of *Hylarana tytleri*. Ohler and Mallick (2002) also mentioned that *H. tytleri* differs from *H. taipehensis* in having two distinct brown lines on the inner side of latero-dorsal folds. However, in Kamrup District, sympatric populations of individuals with and without brown inner stripes have been recorded (Saibal Sengupta, pers. comm.). *H. tytleri* (with distinct brown inner lines) was also recorded from Garbhanga Reserved Forest of Kamrup district (26°04'39.7"N, 91°43'30.6"E; 90 m asl), Panbari Reserved Forest of Golaghat District (26°37'334"N, 93°32.395"E, 65 m asl), Bansbari of Manas National Park (26°42.654'N, 90°59.847'E; 72 m asl) and Pakke Tiger Reserve (26°54'N, 92°36'E; 210 m asl) of Arunachal Pradesh (pers obs).

Microhylidae

13. *Kaloula pulchra* Gray, 1831
Material: AD/BR 28.

Calling aggregations were recorded from swampy and waterlogged areas in and around human habitations, as well as from forest edges during April to June. Calling was heard by day and at night. During July-August, however, no calling activity was recorded. Juveniles of the species were recorded during May-June. The characteristic yellow mark on side of the back is dark or nearly indistinct in adults, whereas it is bright yellow in sub adults and whitish in juveniles.

Although a burrowing frog, it is also a good climber, and is often seen at considerable heights above ground. In Barkhola, one individual was seen at a height of 3 m, climbing a bryophyte covered tree during a heavy shower. *Kaloula pulchra* has been reported from Nagaland (Romer, 1949), Meghalaya (Hooroo et al., 2002), Mizoram (Sailo et al., 2005), and Cachar District of Assam (Dey and Gupta, 2000). The record of the species from "5 miles north of Tinsukia (Assam)", (AMNH 53081) by Baldauf (1949) is based on a misidentified specimen of *Microhyla ornata* (see http://entheros.amnh.org/db/emuwebamnh/pages/amnh/herpetology/ResultsList.php)

14. *Microhyla ornata* Duméril & Bibron, 1841
Material: None collected.

Individuals (n > 10) were seen calling from under moist grasses in open areas around habitation as well as at forest edges during May-August. Chorus of the species are commonly heard in and around human habitation, as well as along forest edges and in plantations.

15. *Microhyla* cf. *butleri* Boulenger, 1900
Material: AD/BR 19–21.

Five individual (SVL 18.50–22.52 mm) were collected on 2 May from Shibtilla in Bihara. Individuals were active on ground in fallen bamboo leaves on a sloping area near paddy field at 1930 h. When disturbed, they jump onto leaves of low shrubs, 10–30 cm above the ground. More material needed to ascertain the systematic status of *M.* cf. *butleri* in Assam.

16. *Microhyla* sp.

Two individuals of this unidentified species were recorded in the month of April from under brick piles in Maruacherra village. They were sympatric with *M. ornata* but differs in having a relatively stout body, lack of typical dorsal pattern and dorsum with a mid dorsal series of distinct warts. We herein consider it as a member of *Microhyla ornata* complex (Saibal Sengupta, pers. comm.).

Megophryidae

17. *Leptobrachium smithi* Matsui, Nabhitabhata & Panha 1998
Material: AD/BR 17.

Individuals of the species were heard calling from following localities Chandrapur, Maruacherra, Duiganga, Abong Punjee, and Damcherra.

The characteristic loud Quak..Quak..Quak… call typically starts at dusk and continues until ca. 2100 h. A lone individual (SVL 53.05 mm) was found sitting on a rock just near fast flowing Chamduba Stream at 2300 h. It did not attempt to escape when caught. Choudhury et al. (2001) recorded metamorphosed individuals of this frog during February; however during the present study, metamorphs were recorded during the month of April.

Rhacophoridae

18. *Philautus* sp.
Material: AD/BR 22.

One individual (SVL 17.74 mm) was taken from on a leaf, ca. 2 m above ground in the Chandrapur area, in late March. A calling aggregation was observed on leaves of small bushes at forest edges and on degraded hill slopes.

19. *Polypedates leucomystax* (Gravenhorst, 1829)
Material: AD/BR 26.

Individuals were seen throughout the study period, in and around human habitations, plantations, secondary forest habitats, and roadside vegetation. Most were observed at a height of 0.3–2 m above ground.

20. *Polypedates* sp.
Material: AD/BR 25.

One individual (SVL 57 mm) was collected from among bushes along Gubicherra stream in the month of August. Resting individuals were encountered in thick overhanging vegetation and banana clumps near flowing streams with large boulders. Resembles *P. leucomystax* in colouration, size and dorsal body pattern but differs in lacking skin co-ossified to forehead.

21. *Rhacophorus maximus* Günther, 1858
Material: AD/BR 23.

A single individual (SVL 104 mm) was recorded from near Maruacherra stream on the outskirts of Marua village during the month of August 2007. It was sitting on a tree fern (*Cyathea* sp.), ca. 1.3 m above ground.

Reported from Halflong (Chanda, 1994) as well as from Barail Reserved forest (Pawar and Birand, 2001), which is now a part of Barail wildlife sanctuary.

Breeding activity of the species was observed during March-April in following localities: Cherrapunjee (25° 17.016'N, 91° 44.114'E) of Meghalaya, Kamlang Wildlife Sanctuary (27°45.913'E, 96°21.432'E; 530 m asl), Mehao Wildlife Sanctuary (28°03'40.1N, 95°56'13.8"E; 750 m asl), Deban (27°29'32.5"N, 96°22'54.0"E, 455 m asl) of Namdapha National Park of Arunachal Pradesh, Khonoma village (25°36.898'N, 93°57.240'E; 1,895 m asl) of Nagaland and Panbari RF (26°36.164'N, 93°30.024'E; altitude: 160 m asl).

22. *Rhacophorus bipunctatus* Ahl, 1927
Material: AD/BR 11.

Two calling individuals (SVL 34 mm and 38 mm) were observed on shrubs at 1.5 m off the ground near a forest trail at Bandarkhal area of the Sanctuary during June 2007. Earlier, this species was recorded from near the western

boundary (Digorkhal village) of the Sanctuary (Bhaktiar Hussain, pers. comm.).

Bufonidae

23. *Duttaphrynus melanostictus* (Schneider, 1799)

Material: None collected.

Commonly observed in various habitats including forest edges, plantations, road side areas, tea gardens and human habitations, etc. Inger et al. (1984) also noted that the species occurs in variety of habitats, especially in disturbed areas.

Reptilia
Squamata: Sauria

Scincidae

1. *Eutropis multifasciata* (Kuhl, 1820)

Material: None collected.

Encountered on 28 March 2007 at 1000 h in Maruacherra, and subsequently recorded from Abong Punjee, Doloo TE, Digorkhal, Narainchera, Bandarkhal and Nunchuri. Most sightings were in secondary and degraded forest areas, as well as plantations, roadside areas and around human habitations. At night (1900 h–2200 h), individuals were seen resting within bushy vegetation, and also in tree holes, ca. 1–2 m above ground.

2. *Eutropis macularia* (Blyth, 1853)

Material: AD/BR 29.

Recorded from under leaf litter in a dry stream bed inside secondary forest of Chotorampur at ca. 1430 hr. A gravid female was collected in mid June 2007 from bamboo clumps near Narainchera. Activity also noted at night (1800–2000 h), particularly near forest trails.

3. *Eutropis quadricarinata* Boulenger, 1887

Material: ZSIC 25807.

On 16 June 2007 at about 2100 h, a gravid female (SVL 50.70 mm; TL 102.85 mm) was seen resting on a dry branch over a puddle on the edge of secondary forest of Narainchera. The area had extensive cane and bamboo thickets with isolated trees. Four days later (on 20 June, 2007), it produced three eggs, measuring 10.57–10.79 mm in length and 6.31–6.51 mm in width.

Annandale (1905) described *Mabuya anakular* from the Cachar District, which was synonymised with *Mabuya quadricarinata* by Smith (1935). Our individual agrees with Smith's (1935) description of the "Cachar variety" in having uniform brown colouration, without darker markings above. The type specimen of *M. anakular (*ZSIC 2357) is in now in a poor state of preservation. Thus, the present Barail material provides an important addition to the museum collection and also provides a record after a gap of over 100 years from Indian limits. Elsewhere, it has been reported from Myanmar's Chattin Wildlife Sanctuary (Zug et al., 1998).

4. *Eutropis* sp. 1

Material: Not collected.

We sighted this species during two field visits to the Duiganga area of the Sanctuary. An individual was observed foraging among lianas and tree branches next to a water pool. It was seen active among the top fronds of vegetation up to height of ca. 4–5 m, often coming down but rapidly climbing up. It is superficially similar to *E. multifasciata*, but lacks markings on the flanks (in *E. multifasciata,* white spots on the flank region are often present) and is plain coloured dorsally.

5. *Sphenomorphus maculatus* (Blyth, 1853)

Material: ZSIC 25817.

An individual in breeding colour was recorded on 28 March 2007 at 1030 h from Notbeng from the bank of a rocky evergreen forest stream. Another individual in breeding colour was collected 2 April 2007 from Lakhicherra Nullah at 0830 h. It was moving among overhanging vegetation and nearby fallen branches along a small stream. We provisionally refer our specimens to *S. maculatus*, although the dorsal colouration and pattern differs from typical *S. maculatus* and thus could be a cryptic species within the *Sphenomorphus maculatus* complex.

6. *Tropidophorus assamensis* Annandale, 1912.

Material: ZSIC 25813, BNHS 1783.

The first individual (SVL 67 mm; TL 68 mm+, tail tip missing) was encountered in

Adakuchi Basti Stream at 1215 h. It was secreting itself beneath a bryophyte covered boulder on a dry stream bed. A juvenile (SVL 41.23 mm, TL 57 mm) was found under rock at the same area. A third individual was collected in an identical situation near the Chamduba area on 2 April. Unlike other skinks, they remained motionless when uncovered.

The type locality is Harigaj Range, Sylhet Hills (Smith, 1935), then within greater Assam state, and presently within the political boundaries of Bangladesh. This nominal species has been rediscovered at Nengpui WLS of Mizoram after a gap of ~90 years after the original description (Pawar and Birand, 2001). Mathew (2006) reported an individual from a bamboo thicket near a stream from Lunglei District, Mizoram state. However, the present record of *T. assamensis* constitutes the first report of the species from Assam State.

Lacertidae

7. *Takydromus khasiensis* Boulenger, 1917

Material: AD/BR 30.

A gravid female (SVL 40 mm) was collected on 2 April. It was actively foraging among leaf litter at 1230 h near Lakhicherra stream, ca. 1.5 m from water. Two older specimens are present in the collection of Zoological Survey of India, Kolkata (ZSIC 12045–46), from Cachar District, Assam. Das (2002) reports the distribution of this species as Meghalaya, Mizoram and Assam States, as well as Bangladesh and northern Myanmar. Earlier, we had encountered the species among grassy patches near a stream in Cherrapunjee (25°18'29.80"N, 91°42'27.16"E; ~ 1,200 m asl), Meghalaya State.

Agamidae

8. *Calotes emma* Gray, 1845

Material: ZSIC 25806.

A male (SVL 66 mm; TL 170 mm) was observed on 28 March at 1430 h near Tellacherra nullah, a fast flowing stream within evergreen forest. It was sitting on a boulder and jumped into water when approached. Another male was found on 1 September at 1100 h at Gubicherra Pahar (200 m asl). It was basking on a small banana plant, ca. 1 m above ground. A gravid female (SVL 91 mm; TL 235 mm) was observed on 17 April, 2007 at Herhse (23°58'N, 92°41'E; 310 m asl) in Kolasib District, Mizoram.

In north-eastern Thailand, Schaedla (2004) recorded nocturnal feeding by *C. emma* which is unique among the members of diurnal active lizards of the genus *Calotes* (Erdelen, 1988; Günther, 1864; Subba Rao, 1970, 1975).

9. *Calotes versicolor* (Daudin, 1802)

Material: None collected.

This is the commonest agamid in the study area and is typically associated with human-modified habitats, and recorded from throughout the study sites. Individuals were sighted in habitats such as tea gardens, teak plantations, around human settlements, on roadside vegetation, near ponds, forest-habitations and forest-agriculture field edges. Most sightings were in arboreal situations, up to 3 m above ground. Gravid female individuals were collected in the month of September.

10. *Calotes* cf. *irawadi* Zug, Brown, Schulte & Vindum, 2006

Material: ZSIC 25816.

On 4 September 2007, an individual was found near Tellacherra stream at 2030 h. It was resting inside a bushy thicket, 1.30 m above ground and 3 m away from the stream. The dorsal colouration was yellowish with blackish spots. When excited, a middorsal series of black diamond shaped spots was seen. Morphologically, the individual is similar to *Calotes irawadi* (see Manthey, 2008). Collection of fresh material and subsequent comparison with recently described species of *Calotes* from Myanmar (Zug et al., 2006) will probably help in identifying this species.

11. *Calotes jerdoni* Günther "1870" 1871

Material: ZSIC 25815.

A female (SVL 13 cm, TL 29 cm) was recorded in September, at 1140 h. It was collected from shrubs (1 m off ground) at the edge of a jhum field, on a slope near Jatinga village. *C. jerdoni* is a common montane agamid of north-eastern India. In our previous field surveys in southern Nagaland (Kohima) and Ukhrul district of northern Manipur (25°07.409'N; 94°26.547'E, 2,025 m asl), *C. jerdoni* was com-

monly encountered around habitations, roadside shrubbery, agricultural lands and along forest trail between altitudes 1500–2350 m. In Nagaland, both green and brown colour morphs were observed, the two Ukhrul individuals were green with two distinct longitudinal brown lines on dorsum; however, the Barail specimen was uniform green in colour. A black colour morph of the species is also known. (Ulrich Manthey, pers. comm.).

12. *Japalura planidorsata* Jerdon, 1870

Material: ZSIC 25808, ZSIC 25809, ZSIC 25810.

Five individuals of this species were recorded on 2 April. They were observed among thick foliage along a fast flowing stream at around 1230 h. The male individuals (SVL 33.00–38 mm; TL 62.00–73 mm) are smaller than the females (SVL 39.00–42 mm; TL 73.00–75 mm). Breeding males are with yellowish-cream stripe from snout to shoulder. The gular region of males are orange coloured. When disturbed, tried to take refuge under large bryophyte covered rocks near the streams, using a hopping motion to escape. When handled, one male individual feigned death.

Gekkonidae

13. *Cyrtodactylus khasiensis* (Jerdon, 1870)

Material: Not collected.

A single individual of the species was encountered on 24 May at 1900 h in Chandrapur area of Naraincherra. The individual was seen on the side of forest trail.

14. *Gekko gecko* (Linnaeus, 1758)

Material: None collected.

On 29 March 2007 at 0930 h, we heard the call of this species in Notbeng, a degraded forest on a hill slope besides Jatinga River. Six individuals were seen on a *Ficus* tree at 5 m above ground in Chotorampur area. Vocalization was heard intermittently on the next day from hills near Lakhicherra Nullah. Zug et al. (1998) observed that *G. gecko*, presumably males, call irregularly throughout the day and night from February into June. On 24 May, two juveniles were observed on a *Ficus* tree, ca 2 m above ground near Naraincherra.

15. *Hemidactylus frenatus* (Duméril & Bibron, 1836)

Material: None collected.

This species was recorded largely from human habitations and dilapidated houses at various localities of the study area. Within human surroundings, this species was mainly observed in cracks of walls and crevices, up to a height of 4 m. Individuals were also seen in a *Ficus* tree hole, ca. 1m above ground.

16. *Hemidactylus platyurus* (Schneider, 1792)

Material: ZSIC 25819.

This species was recorded in the morning of 28 March near Maruacherra, a single individual was seen basking on a tree. The surrounding area was covered with secondary forest with extensive bamboo growth.

In Nilachal hills near Guwahati city, these geckos are often found in association with *Ficus* trees and large rocks during the day (Das, 2002), this microhabitat also noted by Schleich and Kästle (2002).

Varanidae

17. *Varanus bengalensis* (Daudin, 1802)

Material: Not collected.

A single individual was sighted on 15 April, at 0945 h near Bhandarkhal ca. 1 km away from human habitation. It was basking on the roadside (slope >70°).

Varanus is consumed locally. We have seen photographs of *Varanus* on sale in local market at fringe areas. According to villagers, the *Varanus* population declined over the years in and around study area.

Squamata: Serpentes

Typhlopidae

1. *Typhlops diardii* Schlegel, 1839

Material: ZSIC 25812.

Recorded on 16 June, at 1830 h, from Chandrapur forest edge. Known to lead a secretive subterranean existence (Khan, 1998), but this individual was found under tree bark, at 40 cm above water level of a waterlogged area. The freshly collected individual was dull whitish in colouration. Two day later, it shed its skin and

regained its usual dark brown metallic colouration.

Pythonidae

2. *Python molurus bivittatus* (Linnaeus, 1758)
Material: None collected.

On 2 April, we encountered a dead individual on Lakhicherra Pahar, at 339 m elevation. The individual was ca. 3 m in total length. We presume that the snake died from forest fire which completely destroyed the undergrowth vegetation of the hill slope.

Subsequently, another male (SVL 2.3 m, TL 106 cm) was rescued from human habitation of Moynagarh, in the month of July.

Colubridae

3. *Amphiesma stolatum* (Linnaeus, 1758)
Material: None collected.

Recorded as abundant from Dolu tea estate, Barkhola village,Subhong Punjee, Balachera and Bihara, all around human habitation and secondary forest edges. Many were seen as road kills, mainly near human habitation on the Silchar-Halflong road. Threat display consists of erection and expansion of the first third of the body.

4. *Ahaetulla prasina* (Reinwardt in Boie, 1827)
Material: AD/BR 50.

A male (SVL 730 mm; TL 425 mm) was recorded on 20 June at 0930 h from forest edge at Chandrapur. The velvety green individual was observed on a banana clump, devouring a medium sized *Calotes* cf. *versicolor.*

5. *Boiga cyanea* (Duméril, Bibron & Duméril, 1854)
Material: AD/BR 38.

A male (SVL 1205 mm; TL 375 mm) was recorded on 30 August at 0930 h from Lakhicherra stream. It was resting among overhanging branches of a large streamside tree, ca. at 1.8 m above flowing water. When captured, it tried to climb up rapidly. It was in pre-moulting condition, with distinct eye caps.

6. *Boiga ochracea* (Günther, 1868)
Material: AD/BR 57.

A single female (SVL 540 mm; TL 145 mm) was found inside a dry bamboo internode in Putichera area. The locality is a degraded forest on a low hill with extensive bamboo clumps.

7. *Coelognathus radiatus* (Boie, 1827)
Material: None collected.

A single female was collected from a *Ficus* tree, at ca. 1.5 m height in the late afternoon. When threatened, it formed 2–3 loops with the fore body, keeping the mouth wide open and vibrating its tail. Our individual feigned death when handled. According to local people, this species is frequently encountered in paddy fields during the harvesting seasons.

8. *Dendrelaphis cyanochloris* Wall, 1921
Material: AD/BR 40.

A female (SVL 850 mm; TL 343 mm) was encountered on 30 August, at 1430 h, among woody shrubs on a Bhaluknala streamside slope (> 50°). Sensing our presence, it climbed up and took refuge on a top frond (6 m high) of a *Duabhanga grandifolia* sapling. When caught, it flattened its forebody, exposing the sky blue and white interstitial skin and attempted to bite.

9. *Dendrelaphis pictus* (Gmelin, 1789)
Material: AD/BR 41.

The first juvenile was recorded at noon from the Chotorampur area, from the edge between degraded forest and tea garden, and was seen among high grass (*Saccharum* sp.). Another was encountered while crossing a forest trail near a jhum field in Abong Punjee. A third individual, a gravid female (SVL 705 mm; TL 355 mm) was collected from a bamboo clump near human habitation of Naraincherra during the month of April. A male undergoing ecdysis was recorded from high grass in the Chandrapur area during June. When caught, the snake exposed the sky blue interstitial scales, but did not attempt to bite.

10. *Lycodon aulicus* (Linnaeus, 1758)
Material: None collected.

One individual (SVL 530 mm, TL 130 mm) of this widely distributed species was recorded inside a thatched house at 2000 h, from Abong Punjee.

11. *Lycodon jara* (Shaw, 1802)

Material: AD/BR 37.

On 16 June 2007, a female (SVL 320 mm; TL 74 mm) found crossing a waterlogged area, at the Naraincherra forest edge. When handled, it tried to hide its head under its body coil and never attempted to bite.

12. *Oligodon albocinctus* (Cantor, 1839)

Material: AD/BR 64.

During June, a juvenile (SVL 270 mm; TL 47 mm) was found among the prop roots of an unknown tree at 0820 h at ca. 30–40 cm above ground, on a hill slope (~60°), well canopied with extensive growth of *Calamus* sp. oin the understory.

13. *Psamodynastes pulverulentus* (Boie in: Boie, 1827)

Material: ZSIC 25814.

On 28 March at 1230 h, a juvenile (SVL 160 mm; TL 45 mm) was recorded from dry leaf litter from Borthol Teak plantation area. On 5 June at 1000 h, another female (SVL 402 mm; TL 95 mm) was recorded from Chandrapur. It was found among fallen leaves on the steep stream bank. Both individuals were recorded below 80 m elevation. David and Vogel (1996) reported that the species is found from sea level up to 2000 m inhibiting lowland tropical wet and dry forests, tropical and subtropical wet montane forests, bamboo forests, moist scrublands, marshes and swamps, rice paddies, hedges and gardens in the suburban areas.

14. *Ptyas korros* (Schlegel, 1837)

Material: Not collected.

One individual was seen resting inside thick grassy clump near Tellacherra nullah (40 m asl) at around 1900 h. David and Vogel (1996) mentioned that this species is known from sea level up to 1,500 m. However, in north-east India, this species has been recorded at an elevation of 2,000 m from Khonoma village in Nagaland, where it occurs sympatrically with *Ptyas nigromarginatus* (Das and Ahmed, 2007).

15. *Ptyas mucosa* (Linnaeus, 1758)

Material: AD/BR 63.

This species was recorded in Doloo Tea Estate, Abong Punjee, Narainchera, Nunchuri and was always encountered in and around human habitation. A female (SVL 1300 mm; TL 390 mm) was killed by local villagers near Maruah Village.

16. *Pareas monticola* (Cantor, 1839)

Material: AD/BR 56.

A road kill was recorded near Bandarkhal village during August. The road segment bordered a swampy area on one side and forested hill on the other.

In Mizoram, an individual was found resting among the leaf of *Forrestia* sp. growing along a forest stream. The species was reported from Kaziranga National Park (Mathew, 1983) and we observed the species from Podumoni Wildlife Sanctuary (27°24'51"N, 95°18'39"E, 120 m asl) in Tinsukia District, Hengrabari (26°09'.53.4"N, 91°47'33.0"E, 175 m asl), Kamrup District, Assam. Individuals from Upper Assam and that from Mizoram show variations in dorsal pattern, also noted by Athreya (2006).

17. *Rhabdophis subminiatus* (Schlegel, 1837)

Material: ZSIC 25821.

A male (SVL 427 mm; TL 160 mm) was recorded from tea garden-forest edge of Naraincherra.

18. *Rhabdophis* sp.

Material: ZSIC 25825, ZSIC 25826, ZSIC 25827, ZSIC 25828.

The first individual of this natricine was encountered on 28 March 2007 at 1100 h near Lakhicherra Nullah. A male (SVL 495 mm; TL 145 mm) was seen near a water puddle among leaf litter. On 2 April 2007 at 1630 h, the second female (SVL 465 mm; TL 123 mm) was collected from human habitation of Maruacherra. When handled, it regurgitated a partly digested *Hylarana leptoglossa*. The third male (SVL 610 mm, TL 195 mm) was collected on 26 May 2007, at 0945 h, from among accumulated plant material near a water puddle, ca. 3 m away from the fast flowing Lakhicherra stream. The fourth and the largest male (SVL 600 mm, TL 230 mm) was captured from Lakhicherra Jhum field on a hill slope above Lakhicherra stream. It was active at dusk.

The species closely resembles *Rhabdophis himalayanus*, but differs from the type specimens (BMNH 1946.1.23.75 and BMNH 1946.1.13.15) in having a reddish chevron mark (vs. a distinct collar in *R. himalayanus*) on the neck and having an unpatterned venter (vs. ventrals with dark mottling in *R. himlayanus*).

All individuals were docile, never attempting to bite when handled. The largest male broke its tail while being handled, a phenomenon reported in *Xenochrophis*, *Rhabdophis subminiatus, Amphiesma stolatum*.

19. *Xenochrophis piscator* (Schneider, 1799)

Material: AD/BR 60–62.

The first individual was collected at 2000 h from a pond with extensive aquatic vegetation near Naraincherra. A second specimen was collected while it was basking on overhanging vegetation of a pond. The third was seen on a moist rocky streambed in degraded forest at Chtorampur.

The three individual differ in dorsal colouration. AD/BR 60: is olive with a narrow inverted V nuchal mark; faint dorsal markings only on anterior part; posterior body and tail without any markings; no postocular stripe. AD/BR 61: yellowish with dorsal scales edged with black only anteriorly, posterior part unpatterned; no nuchal markings but two distinct postocular stripes present. AD/BR 62: dorsum with conspicuous large black blotches darker anteriorly, lighter posteriorly; an inverted "V" nuchal mark; post ocular stripe distinct.

However, in all three individuals, the venter was white, with the scales darker only at the outer edge. Vogel and David (2006) remarked that, in the closely related species *X. schnurrenbergeri* and *X. flavipunctatus* the ventral and subcaudal scales all with entire, broad, dark markings.

Viperidae

20. *Cryptelytrops erythrurus* (Cantor, 1839)

Material: AD/BR 42–43 AD/BR 55, ZSI 25820.

A male (SVL 435 mm; TL 134 mm) was collected on 14 June 2007 from Naraincherra village. It was found among piled up pumpkins kept 2 m above ground. Another male (SVL 325 mm; TL 75 mm) was encountered on the bank of Jatinga River at 2200 h. A large female (SVL 670 mm; TL 100 mm) was recorded on 4 September at 2200 h from Borthol. This individual was seen coiled among leaves of an overhanging branch 3 m above fast flowing Borthol stream.

21. *Ovophis monticola* (Günther, 1864)

Material: ZSIC 25811.

On 16 October, a single juvenile (SVL 200 mm; TL 45 mm) was found under boulders of a landslide area near Jatinga Village (~800 m asl). Earlier, this species was mainly encountered between an altitude of 1,000–2,000 m asl in Meghalaya and Nagaland. In Nagaland, we noted gravid individuals in the months of June-July.

Elapidae

22. *Bungarus niger* Wall, 1908

Material: AD/BR 52.

On 25 August, we encountered a male (SVL 832 mm; TL 135 mm) near Damcherra Village. It was crossing the Silchar-Halflong road at ca. 1900 h. Earlier reported from Cachar District by Grosselet et al. (2004). Wall (1909, 1911) recorded it from elevations up to 4,000 ft (= 1,220 m) from northern West Bengal. Schleich and Kästle (2002) reported the occurrence of the species up to 1,450 m asl.

23. *Bungarus fasciatus* (Schneider, 1801)

Material: None collected.

A single individual was observed near human habitation of Maruacherra Basti, at 1930 h. The locals informed us that they often encounter this species at night, especially after heavy showers.

24. *Naja kaouthia* (Lesson, 1831)

Material: None collected.

The brown variety was collected from Abong Punjee during the survey. This individual was under stacked firewood of a degraded forest edge. Recorded from human habitation of Dolu Tea Estate and paddy fields of Barkhola Village.

25. *Ophiophagus hannah* (Cantor, 1836)

Material: None collected.

On August, a male (SVL 303 cm; tail missing) was killed by villagers in Nunchuri when it ventured near a house during the day. Prior to

this survey, an adult was rescued by members of a local NGO from human habitation at Bihara Village (photographic evidence). We saw a piece of skin from Maruacherra Village, which was reported to have been killed by villagers in 2005, from adjoining Pan Jhum field when it attacked their hunting dog during day time. Local Khasi tribesmen believed that the tail of the species has medicinal value. In north-eastern India, this species is recorded up to 1,700 m elevation (Das et al., 2008).

Testudines

Testudinidae

1. *Manouria emys* (Schlegel and Müller, 1844)

Material: None collected.

One live individual (SCL 30 cm) was seen in a village house at Bandarkhal. The owner reported that he collected it on "Bandarkhal hill" at the northern boundary of Barail Wildlife Sanctuary, from a bamboo thicket during February 2007 with the help of his dog, and was kept as a pet.

In north-eastern India, this species has been recorded from Loomajooting in Nagaland; Tarapung area, Kalyani Reserved Forest, Near Maibong, Langting-Mupa Reserve Forest, Barail Range, Innerline Reserve Forest of Assam; Nongkhyllem Wildlife Sanctuary, Balpakram National Park of southern Garo hills of Meghalaya, Phura and Sangu in Saiha District and Dampa Tiger Reserve of Mizoram (Anderson, 1871, 1872; Das, 1995; Choudhury, 1996; Choudhury, 2001, Pawar and Choudhury, 2000).

Geoemydidae

2. *Cuora mouhotii* (Gray, 1862)

Material: None collected.

On 31 May 2007, we examined a shell of a freshly-killed individual from Bandarkhal Village. The owner of the shell stated that he collected it in November 2006 near a rocky forest stream on Nimatha Hill (1,100 m asl). Subsequently, another shell was examined from Chotorampur village of Bijoypur TE, which was collected near a logging trail on Maruacherra Hill during the winter. According to Ernst and Barbour (1989), the species is terrestrial and seldom enters water.

This species was reported from Cachar Hills and Kopali River of North Cachar Hills by Anderson (1871). Elsewhere it was reported from Dhansiri Reserved Forest of Karbi Anglong (Choudhury, 1993); Garo and Khasi hills of Meghalaya (Das, 1991); Durpong RF of Papum Pare District of Arunachal Pradesh (Choudhury, 1995), Mehao Wildlife Sanctuary, Namdapha National Park of Arunachal Pradesh (Bhupathy and Choudhury, 1992; Das, 1991).

▪ *Cyclemys gameli* Fritz, Guicking, Auer, Sommer, Wink & Hundsdörfer, 2008

Material: Not collected.

On 2 April 2007, a male was collected from thick leaf litter of Lakhicherra plateau (ca. 300 m asl). It measured: straight carapace length 107 mm, straight carapace width 90 mm, curve carapace width 103 mm, greatest plastral length 98 mm. The specimen was subsequently released.

A shell was examined at Naraincherra village, which measured as follows: carapace length 220 mm, greatest plastral length 190 mm, shell height 80 mm. These measurements are close to the higher end of the range reported by Schleich and Kästle (2002) and Das (2002).

In a recent revision of the *Cyclemys*, Fritz et al. (2008) described *C. gemeli* based on a collection from Tezpur to Arunachal Pradesh, 5 km to border of Arunachal Pradesh, Jia Bhoroli River Region, Assam, India. They revealed that, *Cyclemys* in north-east India, northern West Bengal, Uttar Pradesh (Nepal Border) are *C. gemeli* and not *C. oldhami* as was previously believed (see Fritz et al., 1997). We assigned the Barail specimen to *C. gameli* based on extended morphological description of *Cyclemys gameli* by Praschag et al (2009).

Discussion

The present inventory comprises 45 species of reptiles and 23 species of amphibians. Among reptiles, the lizards are represented by 17 species in five families and 10 genera; snakes consist of 25 species in five families and 19 genera and tortoise and turtles comprise three species in two families and three genera. Among the saurians, Scincidae is the dominant family (six species) followed by Agamidae (five species) and Gek-

konidae (four species). The saurian families, Lacertidae and Varanidae, are represented by a single species each, i.e., *Takydromus khasiensis* and *Varanus bengalensis,* respectively. The recorded snake diversity is dominated by members of the family Colubridae (17 species) followed by Elapidae (four species) and Viperidae (two species). The families Typhlopidae and Pythonidae are represented by one species each, i.e., *Typhlops diardii* and *Python molurus bivittatus,* respectively.

All 23 recorded species of amphibians were anurans, and are distributed in six families and 16 genera. Dicroglossidae is the most diverse family, represented by seven species followed by Ranidae and Rhacophoridae (five species each) and Microhylidae (four species). The families Bufonidae and Megophrydae are represented by a single species, *Duttaphrynus melanostictus* and *Leptobrachium smithi,* respectively.

The highlight of the present study is the record of rare and poorly known forest skink species- *Tropidophorus assamensis* and *Eutropis quadricarinata.* Both these lizards have rarely been reported since their description. We also present the first reproductive data of *Eutropis quadricarinata* (see Das, 2002).

During the present survey, several herpetofaunal species were recorded, the identity of which are either unknown or conferred to closely related species. The positive identification of these species will follow with additional survey, the generation of new data and further collaborative work with appropriate specialists. These provisionally identified species may represent previously unknown species, or variants of species already included in this list. Among amphibians these poorly identified species include *Occidozyga* sp., *Amolops* sp., *Philautus* sp. and *Microhyla* sp. and among reptiles, includes *Rhabdophis* sp.

Many of the species encountered during the survey are still members of cryptic species complexes. Species complexes are groups of morphologically similar species that in the past have been recognized as single species such as *Polypedates leucomystax* (fide Inger, 1999). According to Bain et al. (2003), most of the species complexes are widespread, although the member species can have only limited ranges within this broad range. Among reptiles, some species complexes encountered are *Boiga ochracea* (fide Smith, 1943), *Ovophis monticola* (fide Leviton et al., 2003), *Calotes emma* (Manthey, 2008), *Cyrtodactylus khasiensis* (fide Samrat Pawar, pers comm.) and *Ophiophagus hannah* (fide Das, 2002).

The number of species encountered in our study is lower than that of other known inventory in the north-eastern India (Pawar and Birand, 2001; Sengupta et al., 2000; Ahmed et al., 2004; Athreya, 2006). Our results are based on a survey constrained by time, and comprised a single rainy season. Extensive and long term field surveys will no doubt significantly add to the herpetofaunal records of this area. This assumption is supported by the sharp slope in the species accumulation curve (Fig. 2) from the present survey. This prevents from making any approximation of the species diversity in the study area. Species that were not recorded during this survey but are known from Cachar and the adjoining North Cachar Hills include *Boiga siamensis* (ZSIC 8718), *Boiga gokool* (ZSIC 14746), *Chrysopelea ornata* (ZSIC 14734) and *Oligodon cyclurus* (ZSIC 14731). Discussion with the local inhabitants indicated the presence of few interesting "tree frogs" and "green-backed forest stream dwelling frogs.

Among the recorded species, *Python molurus bivittatus* and *Varanus bengalensis* have been

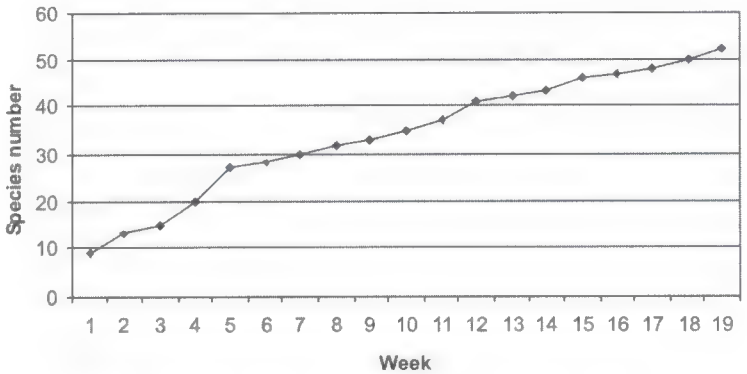

Figure 2. Species accumulation curve for the present study.

accorded the highest legal protection status, under Schedule I of the Indian Wildlife (Protection) Act, 1972. Four species- *Naja kaouthia, Ophiophagus hannah, Ptyas mucosa* and *Xenochrophis piscator* are listed in Schedule II, all other snake species are listed under Schedule IV of the Act. Five species, namely, *Naja kaouthia*, *Ophiophagus hannah*, *Ptyas mucosa*, *Manouria emys* and *Cuora mouhotii* are listed in Appendix II of CITES. Two species of Testudines recorded in the area, *C. mouhotii* and *M. emys,* are also categorized as "Endangered" under the IUCN Red List. Unfortunately, due to lack of awareness and also literally non existent law enforcement machinery, species like *Varanus bengalensis*, *Hoplobatrachus tigerinus* and turtles are killed and consumed by many locals. During the field survey period, discussions with locals were held to increase awareness of the importance of conserving herpetofaunal species.

Barail Wildlife Sanctuary harbours some of the last remaining lowland evergreen forest patches in north-eastern India. Considering the scarcity of knowledge of diversity, distribution and many other aspects of the herpetofauna of the region, the present study assumes significance. Further exploration of the region, including the interior mountain area of Nagaland and the North Cachar Hill District, is our next priority.

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A collection of amphibians and reptiles from the Mekong river, north-eastern Cambodia

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(with 28 text-figures)

ABSTRACT.– **Three herpetological surveys were conducted along a 130-km section of the Mekong River in north-eastern Cambodia, in 2006 and 2007, over three seasonal periods, the early dry, mid dry and wet seasons. Most sampling effort focused on a 56-km section of river, midway between Kratie and Stung Treng Towns, which until the 1990s was largely off-limits due to security restrictions and now supports the most intact riverine habitats and lowest human densities in the study area. Fifty-six species (16 frogs, six turtles, 17 lizards, 17 snakes) were recorded, including the second country records for a gecko (*Hemiphyllodactylus yunnanensis*) and a snake (*Homalopsis nigroventralis*), a range extension for another snake (*Enhydris longicauda*), and six threatened turtle species (*Heosemys grandis*, *H. annandalii*, *Malayemys subtrijuga*, *Indotestudo elongata*, *Amyda cartilaginea* and *Pelochelys cantorii*). Turtles, large lizards and snakes are hunted for commercial trade and local consumption. A crocodilian, *Crocodylus siamensis*, reported to have occurred historically, appears to be locally extirpated or nearly so. Conservation priorities are discussed and comparisons are made with species richness elsewhere in Cambodia.**

KEY WORDS.– **Cambodia, Kratie, Stung Treng, Mekong River, herpetofauna.**

Introduction

Most of Cambodia (86%, 155,000 km^2) lies within the Mekong Basin and comprises a single physiographic unit, the Mekong Lowlands, a vast expanse of seasonal floodplains and low relief centered on the Mekong River and Tonle Sap Lake (MRC, 2003; Fig. 1). The Mekong Lowlands also span southern Laos, south-eastern Thailand and the Mekong Delta in Vietnam. They are of outstanding significance for biodiversity and support some of the best remaining examples of riverine ecosystems in mainland South-East Asia (Baltzer et al., 2001; Seng et al., 2003; Tordoff et al., 2005; Campbell et al., 2006; Baird, 2007). They also support the highest human populations and most productive fisheries and agricultural lands of the entire basin (ICEM, 2003), and habitat conversion for cultivation, plantations, hydropower and infrastructure is proceeding rapidly. Cambodia's inland fishery, the fourth largest in the world (Baran et al., 2007), is focused particularly along the Mekong River and Tonle Sap Lake, and wild aquatic animals, mainly fish but also turtles, lizards and snakes, comprise 40–80% of animal protein for many lowland communities (Meusch et al., 2003; MRC, 2003). Defining conservation priorities for the lowlands is critical yet is hindered by the absence of baseline biological data for many taxa, including herpetofauna.

Amphibians and reptiles are the least studied of Cambodia's vertebrate fauna. Due largely to intensive civil conflict since the 1970s, there has been little contemporary herpetological research

and the principle publications remain a series of classic works for French Indochina (Bourret, 1936, 1941, 1942) and a monograph on Cambodian snakes (Saint Girons, 1972). Since the relaxation of security restrictions in the 1990s, there has been a resurgence of national herpetological studies.

In the Cambodian Mekong Lowlands, previous studies have focused on a small number of taxa under global threat or of economic importance to local communities, including the trade and reproductive biology of watersnakes in the Tonle Sap Lake (Stuart et al., 2000; Murphy et al., 2002), trade and distribution of turtles (Touch et al., 2000; Lehr and Holloway 2000, 2002; Stuart et al., 2002; Stuart and Platt, 2004) and status, distribution and farming of crocodiles, especially the critically endangered Siamese crocodile *Crocodylus siamensis* (Ratanakorn, 1992; Cheang and Ratanakorn, 1994; Nao, 1998; Platt et al., 2004; Sovannara, 2004; Simpson and Han, 2004; Jelden et al., 2005; Platt et al., 2006a; Rab et al., 2006). Preliminary collections of amphibians and reptiles were made in lowland forest in Mondulkiri Province, eastern Cambodia (Long et al., 2000) and Prey Long forest in northern Cambodia (Olsson and Emmett, 2007), and observations of some reptiles in trade (principally varanids, turtles and large snakes) have been made in settlements along the Mekong River in Stung Treng Province, as well as urban markets (Baird, 1993; Martin and Phipps, 1996; Singh et al., 2006b; Timmins, 2006). Elsewhere in the lowlands, limited collections (Davidson et al., 1997; Stuart, 1998; Teynié et al., 2004; Teynié and David, 2007; Stuart and Heatwole, 2008) and status surveys for *C. siamensis* (Bezuijen et al., 2006; Cox and Phothitay, 2008) have been conducted in southern Laos. Studies of watersnake assemblages have been conducted in the nearby Khorat Basin in Thailand (Karns et al., 2005).

Most herpetological studies in Cambodia have instead focused on two mountainous regions outside the Mekong Lowlands, the Cardamom Mountains in the south-west, and hilly regions in the east. In the Cardamoms, surveys have documented taxonomic diversity (Daltry and Chheang, 2000; Swan and Daltry, 2000; Daltry and Wüster, 2002; Long et al., 2002; Ohler et al., 2002; Chuaynkern et al., 2004; Stuart and Emmett, 2006; Grismer et al., 2007a,b, 2008a,b), and conservation of *C. siamensis* (Daltry and Chheang, 2000; Daltry et al., 2003, 2004; Platt et al., 2006b; Simpson et al., 2006a,b) and another threatened reptile, river terrapin *Batagur baska* (Holloway et al., 2003; Platt et al., 2003; Holloway and Heng, 2004). Efforts to conserve the Cardamom population of *C. siamensis* form the largest conservation activity for any reptile in Cambodia (SCWG, 2004). In hilly eastern Cambodia, a collection of amphibians and reptiles was made in Stung Treng, Mondulkiri and Ratanakiri Provinces (Stuart et al., 2006), and in Virachey National Park in the north-east (Emmett et al., 2007).

Here we describe a new collection of amphibians and reptiles from the Mekong River in north-eastern Cambodia. This study was undertaken as part of the first systematic biological surveys of the study area (Bezuijen et al., 2008). We present records for all herpetofauna we documented except one, a threatened turtle *Pelochelys cantorii*, for which survey records and subsequent conservation efforts by several agencies (Cambodia Turtle Conservation Team and D. Emmett unpub. data; Bezuijen et al., 2008) will be presented elsewhere.

Study area

Surveys were conducted over 130 km of the Mekong River between Stung Treng and Kratie Towns in Stung Treng and Kratie Provinces (Fig. 1; Table 1). This section of the Mekong is globally important for waterbirds, fish, and a threatened deer, largely due to the seasonal richness and complexity of its riverine habitats (Bezuijen et al., 2008, and references therein). Here the Mekong has a wide, braided channel with many islands and is subject to large and rapid seasonal changes in flow volume and speed, and a 10+ m range in water level. There is a pronounced seasonal tropical monsoon cycle with a 'dry, cool' season (December-April) and a 'wet, hot' season (May-October), which strongly influences the annual flood pulse of the river. Mean annual rainfall ranges from 1,441–2,600 mm (0 mm in January and 469 mm in September) and at Kratie Town, mean monthly river discharge ranges from 2,220 (April) to 36,700 (September) cubic metres per second (MRC, 2005; Try and Chambers, 2006; Kratie meteorological sta-

Table 1. Geographic coordinates of survey and collection localities mentioned in the text.

Locality	Latitude (N)	Longitude (E)	Province	District
Stung Treng Town, Mekong River (northern limit of study area)	13°31'54"	105°57'55"	Stung Treng	Stung Treng
Kratie Town, Mekong River (southern limit of study area)	12°29'36"	106°13'79"	Kratie	Kratie
'Central section' (northern end)	13°17'55"	105°56'49"	Stung Treng	Siembok
'Central section' (southern end)	13°04'47"	106°13'47"	Kratie	Sambor
Veal Prong Lake (floodplain north-west of Kratie Town)	12°30'26"	105°56'52"	Kratie	Prek Prasap
Kampong Dar Village	12°30'11"	105°56'54"	Kratie	Prek Prasap
Localities in the 'central section'				
Koh Dambong Island	13°10'31"	106°01'26"	Kratie	Sambor
Koh Enchey Island	13°07'48"	106°01'24"	Kratie	Sambor
Koh Kapeung Island	13°11'30"	106°01'29"	Kratie	Sambor
Koh Khlap Island	12°59'48"	106°03'22"	Kratie	Sambor
Koh Khlee-ay Island	13°11'35"	106°01'30"	Kratie	Sambor
Koh Kring Island	13°01'14"	106°02'08"	Kratie	Sambor
Koh Norong Island	13°11'01"	106°01'51"	Kratie	Sambor
Koh Rongnieu Island (northern end of island, opposite Koh Kring Island)	13°00'04"	106°01'50"	Kratie	Sambor
Koh Sompong Island	13°12'53"	105°59'54"	Kratie	Sambor
Koh Tongdaeng Island	13°12'07"	106°01'44"	Kratie	Sambor
Koh Tuk Island	13°11'06"	106°01'30"	Kratie	Sambor
Channel between Koh Enchey & Koh Chroem Islands	13°08'07"	106°01'46"	Kratie	Sambor
Channel between Koh Khlap & Koh Kring Islands	13°00'37"	106°03'17"	Kratie	Sambor
Channel between Koh Khlap Island & mainland	12°59'21"	106°03'15"	Kratie	Sambor
Channel between Koh Khleng Por and Koh Tachan Islands	13°03'13"	106°03'24"	Kratie	Sambor
Channel between Koh Rongnieu & Koh Kring Islands	13°02'33"	106°03'09"	Kratie	Sambor
Channel between Koh Rongnieu & Koh Neang Hen Islands	13°02'33"	106°03'09"	Kratie	Sambor
Prek Krieng River (confluence with Mekong River)	12°55'38"	105°59'30"	Kratie	Sambor
Prek Preah River (confluence with Mekong River)	13°1'33"	106°4'46"	Kratie	Sambor
Bung Rum Lik Lake	12°54'59"	106°00'13"	Kratie	Sambor
Koh Khnhaer Village	12°47'01"	105°57'01"	Kratie	Sambor
Kampong Pnov Village	12°57'34"	106°02'13"	Kratie	Sambor
O Kak Village	12°59'16"	106°03'34"	Kratie	Sambor
Pontacheer Village	13°04'53"	106°04'03"	Kratie	Sambor

tion unpublished data 2007). Although extreme, this seasonal variation is relatively constant and the incidence of flooding is low (MRC, 2005).

Over 40 islands are located in the study area; 18 are >3 km long and the largest, Koh (= island) Rongnieu, is 37x5 km. River width (distance between banks) ranges from 1–11 km. Islands and the mainland have low relief (20–50 m asl). Few permanent tributaries enter this section of the river and the largest are the Prek Krieng and Prek Preah (>70 m wide) and Prek Kandie (<20 m wide). The study area supports at least eight 'deep pools', sections of the riverbed 11–50 m deep which retain water throughout the dry season (Hill, 1995; Viravong et al., 2006) and are seasonal refugia for many aquatic taxa. Small floodplains occur east, west and south of Kratie Town and extend 1–3 km from the river. In the dry season these are extensively cultivated but in the wet season become flooded to 3± m depth. A floodplain west of Kratie, Veal Prong, was visited in the wet season and comprised a series of large, open seasonal lakes with emergent shrubs, grasses and secondary forest.

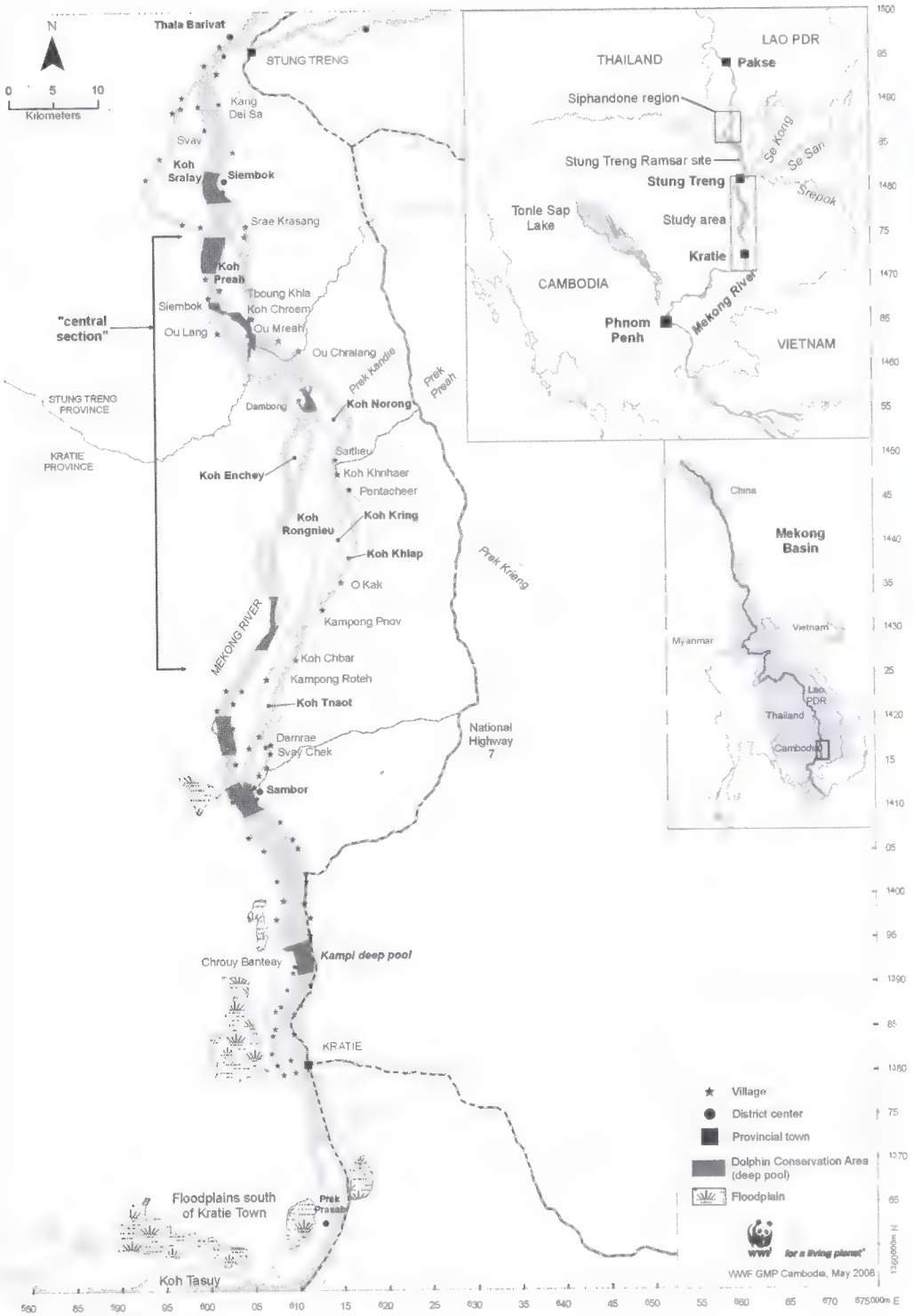

Figure 1. Map of study area.

Kratie and Stung Treng Provinces support some of the lowest human densities in the Lower Mekong Basin (20–70 and 0–20 persons/ km^2 respectively, Hook et al., 2003). The study area encompasses two provincial towns (Kratie, Stung Treng), two district towns (Sambor, Siembok) and approximately 80 villages along the banks of the Mekong, with *c.*77,000 people (20% of the total population of both provinces) (from data in Seila Programme, 2005).

Most of our sampling effort focused on a 56-km section of river midway between Kratie and Stung Treng Towns, which we termed the 'central section' (Fig. 1). Until the late 1990s this area was largely off-limits due to national security restrictions, and now supports the lowest human densities in the study area and some of the most intact riverine habitats remaining in the Lower Mekong Basin (Bezuijen et al., 2008). Most of the islands in the study area are within the 'central section'. West of Koh Rongnieu Island, the Mekong retains permanent flow in the dry season and is the principle transport route for boat traffic. North and east, numerous smaller islands divide the river into waterways which are shallow in the dry season and some of which cannot be accessed by boat. Large areas of the riverbed and riverbanks are alternately exposed or inundated for varying duration in the dry and wet seasons. In the dry season, sandbars hundreds of metres long, rocks, rapids, slow-flowing or standing pools of water, accumulations of wood debris, deep pools, and large stands of shrubs and trees are exposed (Figs. 2–5). In the wet season most of these habitats, including the vegetation, experience complete and prolonged submergence, sometimes for over three months (Fig. 6).

Many of the islands in the 'central section', particularly the central and northern end of Koh Rongnieu, Koh Enchey, Koh Khlap, Koh Kring and Koh Norong, retain mature evergreen, deciduous, and dipterocarp forest types (Maxwell et al., 2008) (Figs. 7–8). Many kilometres of riverbank and the banks of islands remain forested. Small seasonal ponds, streams, and grassy patches occur on the islands and mainland.

The lowest human densities in the study area are in the eastern waterways of the 'central section', which support only eight established villages, with an estimated population in 2007 of *c.*5,500 people (from data in Seila Programme, 2005; personal communication with village heads). A gazetteer with the names and locations of islands and villages in the 'central section' is in Bezuijen et al. (2008).

Similar riverine habitats occur 5–50 km north along the Mekong River, in the Stung Treng Ramsar site, and Siphandon region of Laos (Daconto, 2001; Timmins, 2006).

Materials and methods

We conducted three surveys in three seasonal periods (total 45 field days): early dry season (receding water levels, 10–23 November 2006), mid dry season (low water levels, 10–25 March 2007), and wet season (high water levels, 29 July-13 August 2007). Searches were made in the riverbed, banks, sandbars, and the interiors of islands (seasonal streams, ponds, tributary entrances) especially of Koh Rongnieu, Koh Enchey, Koh Khlap, Koh Kring and Koh Norong Islands. Two of the 45 days were spent at Veal Prong floodplain west of Kratie Town; the rest were largely spent in the 'central section'. Opportunistic observations were made throughout the study area.

We employed four methods to sample the seasonal habitats of the study area. (1) Timed searches (non-area restricted), on foot or by boat, were conducted during the day and night. Boat-based surveys were conducted from an 8.7x1 m wooden boat with 13 HP engine, moving slowly upstream (engine on) or drifting downstream (engine off). At least two observers were always present, but search effort was recorded as the total minutes of searching by a single observer to avoid double-counting. Searches focused on riverbed habitats, the banks of islands and the river, and floodplains. Timed searches targeted all species. (2) Quadrat sampling (area- and time-restricted) was conducted along riverbanks and the interior of islands. Quadrats were 10x10 m and searched for 10 person-minutes. Quadrat searches were conducted during the day and targeted diurnal lizards. (3) Mesh turtle traps designed by Conservation International-Indoburma Programme were placed along riverbanks and sandbars. Traps were small (70x40 cm) or large (180x60 cm), with horizontal openings to enable turtles to enter. Traps were baited with fruit and meat and checked daily. We conducted

trapping during the early and mid dry seasons but not the wet season, when daily rises in water level increased the risk of any trapped turtles drowning. (4) Interviews with local communities. Standardized questions were used which focused on status, use and trade of turtles, *C. siamensis*, and other species targeted by local communities for food or trade (e.g. varanids, the agamid *Physignathus cocincinus*, the snakes *Ptyas* spp. and *Broghammerus reticulatus*, and frogs). All interviewees were residents in the 'central section' and all were male except one, a wildlife trader. We made brief visits to urban markets in Kratie and Stung Treng Towns. Our sampling effort was not equal between methods and instead reflected seasonal conditions (Table 2).

Voucher specimens were caught by hand and collected for most species except turtles, due to their threatened status. Specimens were preserved in 10% buffered formalin and later transferred to 70% ethanol. Tissue samples were taken by preserving pieces of liver or muscle in DMSO/EDTA solution before specimens were fixed in formalin. For some snakes, only the tail tip was collected and the snake was released. Specimens and tissue samples were deposited at the Museum of Vertebrate Zoology, University of California, Berkeley (MVZ). For species for which no specimens were collected, voucher photographs were made and deposited at the Zoological Reference Collection (ZRC) in the Raffles Museum of Biodiversity Research, Department of Biological Sciences, National University of Singapore. Voucher photographs are designated 'ZRC(IMG)' (image).

Measurements were made with dial calipers to the nearest 0.1 mm (for small lizards and all frogs) or with a cloth tape rule to 0.1 cm (for large lizards, turtles and snakes). Measurement abbreviations used are: TL = total length, SVL = snout-vent length, HL = head length (tip of snout to rear of jaws), HW = head width (at the commisure of the jaws), SE = snout-eye length (tip of snout to anterior corner of eye), EYE = diametre of the exposed portion of the eyeball, IO = interorbital width, SCL = maximum straight carapace length including shell projections, SCW = maximum carapace width including shell projections, and PL = plastron length. All specimens were measured within five hours of capture and preserved specimens were measured immediately after euthanasia. Live weight of specimens was measured with a Pesola spring balance to the nearest 0.5 gm (50 gm balance), 1 gm (100 gm balance), 5 gm (500 gm balance) or 10 gm (1,000 gm balance). Large turtles were measured with a 30 kg balance not calibrated for accuracy. All captured individuals were examined for external parasites, physical abnormalities and injuries.

Survey coordinates and capture locations were recorded with a handheld Garmin eTrex Vista GPS. Ambient and water temperature (to 0.5°C), %ground- and canopy-cover (in visually-estimated 10% increments), and weather were recorded during surveys. Global threat status is given for species with IUCN listings of 'Data Deficient', 'Near-threatened', 'Vulnerable', 'Endangered' or 'Critically Endangered' (IUCN, 2008).

During the early dry survey, water levels receded rapidly and the extent of exposed channel habitat was visibly greater by the end of the survey. There was little cloud cover or rainfall and some channels between islands in the river

Table 2. Sampling effort for amphibians and reptiles.

Method: number (unit of effort)	Early dry season (receding water) (Nov-06)	Dry season (low water) (Mar-07)	Wet season (high water) (Jul-Aug 07)
Timed search (day, walking): n (mins)	1 (95 mins)	0	2 (180 mins)
Timed search (day, boat): n (mins; km)	0	0	13 (840 mins; 94.6 km)
Timed search (night, walking): n (mins)	18 (1140 mins)	7 (390 mins)	11 (860 mins)
Timed search (night, boat): n (mins; km)	2 (210 mins; 3 km)	8 (835 mins; 7.1 km)	4 (390 mins; 5 km)
Turtle trap-days	118	77	0
Quadrat 10x10 m: n (total mins; ha)	32 (320 mins; 0.32 ha)	70 (700 mins; 0.7 ha)	70 (700 mins; 0.7 ha)
Interviews	9 (in 7 settlements)	9 (in 8 settlements)	9 (in 9 settlements)

Table 3. Herpetofauna recorded in the study area which occur in 'anthropogenically modified environments' (*sensu* Stuart & Emmett, 2006; Stuart et al., 2006). *Tissue sample also collected.

Taxon	Caught	Collected (MVZ voucher)	Capture site
Bufonidae			
Bufo melanosticus Schneider, 1799	2	none	Koh Rongnieu Island; Veal Prong Lake
Microhylidae: narrow-mouthed frogs			
Kaloula pulchra Gray, 1831	4	none	Koh Khlap Island; Koh Rongnieu Island
Microhyla butleri Boulenger, 1900	2	258381*, 258382*	Koh Enchey Island
Microhyla heymonsi, Vogt, 1911	5	258383*	Koh Rongnieu Island
Microhyla ornata (Duméril and Bibron, 1841)	17	258384*, 258385, 258386, 258387	Koh Kring, Norong & Rongnieu Islands
Microhyla pulchra (Hallowell, 1861)	7	none	Koh Kring, Norong & Rongnieu Islands
Ranidae			
Fejervarya limnocharis (Gravenhorst, 1829)	54	258360*, 258361*, 258362, 258363, 258364	Koh Khlap, Kring & Rongnieu Islands
Hoplobatrachus rugulosa (Wiegmann, 1834)	48	none	Koh Enchey, Khlap, Kring & Rongnieu Islands
Occidozyga lima (Gravenhorst, 1829)	3	258388*, 258389*	Koh Enchey & Khlap Islands
Occidozyga martensii (Peters, 1867)	86	258390*, 258391–258398	Koh Khlap & Rongnieu Islands
Rana erythraea (Schlegel, 1837)	15	none	Khlap, Khlee-ay, Kring, Norong & Rongnieu Islands
Rhacophoridae			
Polypedates leucomystax group (Gravenhorst, 1829)	22	258399	Koh Rongnieu Island
Agamidae			
Calotes versicolor (Daudin, 1802)	8	none	Koh Khlap, Khlee-ay, Kring, Rongnieu & Tuk Islands
Scincidae			
Eutropis longicaudata (Hallowell, 1857)	3	258374*	Koh Kring Island
Eutropis macularia (Blyth, 1853)	84	258375*, 258376, 258377	Koh Kring Island; Koh Rongnieu Island
Eutropis multifasciata (Kuhl, 1820)	2	none	Koh Neang Hen Island; Koh Rongnieu Island
Gekkonidae			
Cosymbotus platyurus (Schneider, 1792)	9	258350*	Koh Khlee-ay Island
Gekko gecko (Linnaeus, 1758)	16	none	Koh Khlap, Khlee-ay, Kring, Norong & Rongnieu Islands
Hemidactylus frenatus (Duméril and Bibron, 1836)	5	none	Koh Khlap Island; Koh Rongnieu Island
Boidae			
Broghammerus reticulatus (Schneider, 1801)	3	none	Koh Kring Island (wild juvenile); Koh Rongnieu Island (captive adult); Kampong Dar Village (captive adult). Locally reported to be 'common'
Colubridae			
Dendrelaphis pictus (Gmelin, 1789)	2	none	Veal Prong Lake
Elaphe radiata (Boie, 1827)	1	none	Kratie Town (wild hatchling)
Homalopsis nigriventralis	1*	none	Kratie Town Market (dead juvenile, SVL 29.9 cm, 7 February 2008)
Enhydris enhydris (Schneider, 1799)	0	258357	Veal Prong Lake (captive adult); Kratie Town Market (20 dead adults, 7 February 2008)
Enhydris plumbea (Boie, 1827)	3	258359*	Koh Enchey Island
Ptyas mucosa (Linnaeus, 1758)	0	none	Koh Khnhaer Village (captive adult); Koh Rongnieu Island (captive adult)
Elapidae			
Bungarus fasciatus (Schneider, 1801)	0	none	Prek Krieng River (captive adult)

could only be accessed on foot. In the mid dry survey, most seasonal streams were dry and large portions of the riverbed were exposed or <1 m depth. There was no rainfall, almost no cloud cover, and many waterways could only be accessed on foot. Boat passage on large waterways was sometimes hindered by shallow, rocky rapids. In the wet season survey, water levels had risen 7–10 m higher than four months previously and most channel habitats were submerged. There were more days of cloud cover than sunshine, rainfall occurred on most days, most waterways could be accessed by boat, and from 3–5 August 2007 it rained continuously.

Results

Fifty-six species (40 reptiles and 16 frogs) were recorded during these surveys. At least 27 of these species (Table 3) are characteristic of 'anthropogenically modified environments' (*sensu* Stuart and Emmett, 2006; Stuart et al., 2006), have broad geographic ranges in mainland South-east Asia, and are not discussed further here. *Crocodylus siamensis* was not recorded during the surveys and is not included in these tallies, but local information is presented due to the threatened global status of this taxon. In the following species accounts, we have largely limited our citation of other national records to published sources, but due to the paucity of published herpetological records for most regions of Cambodia, we have also cited unpublished records, with appropriate caution, for sites from which there is no published information.

Bufonidae

Bufo macrotis Boulenger, 1887

MVZ 258343–258345, Koh Kring Island, 4–5 August 2007; MVZ 258346, Koh Enchey Island, 22 November 2006. One juvenile (SVL 25 mm) and three adult males (SVL 46.4, 47.8, 50.6 mm; HL 10.6, 12.8, 15.0 mm; HW 17.4, 17.5, 27.7 mm; SE 6.2, 6.2, 6.6 mm; EYE 4.2, 4.8, 5.1 mm; IO 4.2, 4.7, 4.7 mm; mass 10, 10.5, 13 gm) agree with the expanded description of Taylor (1962) in lacking cranial crests, having low parotid glands slightly larger than eyelid, large tympanum (equal to or slightly smaller than eye), body covered with tubercles of varying size (those on head smallest), a row of enlarged tarsal tubercles, large, rounded palmar tubercle and tarsal fold absent.

MVZ 258346 (the juvenile) was collected at 1010 h among tree roots on a forested riverbank. The three adult males were collected at night (2000–2125 h): MVZ 258343 was in leaf litter in evergreen forest 200 m from the riverbank and MVZ 258344–258345 were in a large (250+) single-species aggregation of *B. macrotis* along a small forested tributary, 70 m from the mainstream. This aggregation occurred on an evening with full cloud cover and moderate rain (ambient and water temperatures 25°C/28.5°C respectively). On 6 August 2007, two other aggregations were heard on Koh Kring Island, at 2000 h along small forest tributaries. Other *B. macrotis* were observed in all three surveys (early dry, mid dry and wet seasons), along riverbanks and in logged forest over 50 m from the river.

Previously recorded from the Cardamom Mountains (Swan and Daltry, 2000; Ohler et al., 2002; Grismer et al., 2007a); reported, but with no collection or identification details, from lowland forest in eastern Cambodia (Long et al., 2000).

Microhylidae

Glyphoglossus molossus Günther, 1869 (Near-Threatened) (Fig. 9)

Two adults, Koh Kring Island, 8 August 2007, photographed and released [ZRC(IMG) 1.30a–b]; 40 pickled specimens, Kratie Town market, 25 March 2007. Both adults were caught at 0900 h within three metres of each other: one was underneath leaf litter among tree roots in riverbank forest, and the other was floating next to the bank. The pickled specimens were being sold for human consumption.

Recorded in Cambodia by Bourret (1942) and van Djik (unpublished data cited in Ohler et al., 2002).

Calluella guttulata (Blyth, 1855)

MVZ 258347– 258349, Koh Enchey Island, 10 August 2007.

Three small individuals (SVL 15.7, 17.4, 18.6 mm; HL 4.2, 4.3, 5.4 mm; HW 5.2, 7.1, 7.9 mm; SE 2.8, 2.8, 2.9 mm; EYE 1.7, 1.9, 2.0 mm; IO 2.0, 2.5, 2.7 mm; mass 0.4, 0.7, 0.7 gm, sex

not determined) are all metamorphs, and possess a broad, rounded snout, large, projecting inner metatarsal tubercle, a smaller rounded outer metatarsal tubercle, two transverse rows of vomerine teeth and the choanae far forward on the palate. In life the dorsum was dark grey-brown with an irregular orange stripe extending from behind the eye to hind legs. Legs were barred orange and brown. The throat was yellow-orange and belly was grey, both finely speckled with black. Specimens were caught between 1530 and 1630 h in leaf litter within logged evergreen forest 5–70 m from the Mekong River and 30 m from a seasonal pond.

Previously recorded in the Cardamom Mountains, by Stuart and Emmett (2006) and Grismer et al. (2008a).

Microhyla berdmorei (Blyth, 1856) (Fig. 10)

MVZ 258378–258379, channel between Koh Khlap Island/mainland, 16 November 2006; MVZ 258380, Koh Rongnieu Island, 13 November 2006.

Three adult males (SVL 26, 29, 34 mm) agree with Stuart and Emmett's (2006) expanded description by having an obtusely pointed snout, toes fully webbed (reaching the base of expanded discs on toes), third and fifth toes equal in length, inner and outer metatarsal tubercle, dark throat and a distinctive yellow venter. MVZ 258378–258379 were in a chorus of seven calling males in a small ephemeral pool, on a sandbar in the river recently exposed by receding waters. MVZ 258380 was on a riverbank of rocks and sand. All were collected between 2030 and 2130 h. In total, 14 *M. berdmorei* including voucher specimens were observed during surveys, in all seasons (early dry, mid dry, wet), in riverbank vegetation or in forest over 50 m from the nearest waterway, on Koh Rongnieu, Khlap and Kring Islands. Twelve of 14 individuals were observed at night (2030–2100 h) and two were recorded in the day (1154 and 1218 h).

Recorded from lowlands and hills in Cambodia (Bourret, 1942; Swan and Daltry, 2000; Ohler et al., 2002; Stuart and Emmett, 2006; Stuart et al., 2006; Grismer et al., 2008b).

Emydidae

Heosemys grandis (Gray, 1860) (Vulnerable) (Fig. 11)

Wild adult [ZRC(IMG) 2.114a–c], Koh Kring Island, 12 November 2006 (released); fresh remains (plastron), Koh Kring Island, 15 November 2006; one captive individual [ZRC(IMG) 2.113a–b] in Kampong Pnov Village, 11 November 2006, and five in Koh Khnhaer Village (four on 17 November 2006, all photographed, ZRC(IMG) 2.115; one on 9 August 2007).

The seven intact specimens (SCL 18.6–28.2 cm, mean ± SD 24.8 ± 3.6; SCW 15.3–22.8 cm, mean±SD 19.7 ± 2.7; PL 17.0–28.0 cm, mean ± SD 23.3 ± 3.5; mass 0.89–3.3 kg, mean ± SD 2.2±1.0) conformed to the description of Stuart et al. (2001) in having spikes along the posterior margin of the carapace, a pale vertebral keel along the carapace midline, yellow plastron with black lines radiating from a black blotch on each scute, straight seam between femoral and anal scutes, and lack of a plastron hinge.

The wild individual was found in a semi-submerged fishtrap among tree roots along a forested, sandy riverbank and was released. The fresh plastron (PL 13.2 cm) was of a specimen consumed by residents. Residents stated that captive individuals had been caught locally and within a week of our visit. The Koh Khnhaer Village specimens were in the house of a wildlife trader. Another captive *H. grandis* was observed in this village on 1 February 2007 (Sun et al., 2007).

Historically reported from Cambodia (Bourret, 1942); recent records are from the lowlands of south-western Cambodia (Daltry and Traeholt, 2003; Stuart and Platt, 2004) and north-eastern Cambodia (Emmett et al., 2007).

Heosemys annandalii (Boulenger, 1903) (Endangered) (Fig. 12)

Fresh carapace and plastron [ZRC(IMG) 2.112a–d] of a single individual in a local residence, Koh Kring Island, 30 July 2007. The capture site of this individual was shown to us by the resident and was in evergreen forest 300 m from the riverbank, next to a seasonal stream. The carapace and plastron (SCL 13.0 cm, SCW 11.8 cm, PL 12.0 cm) agreed with Stuart et al. (2001) and Stuart and Platt (2004) in having a

raised elongate carapace, no pale stripe on the vertebral keel, and lack of radiating lines on the plastron, and with Taylor (1970) in having a yellow plastron with a black blotch in the lower left corner of each scute. The carapace had a notably raised vertebral keel. The specimen had been caught two days previously by the resident's dog.

Historically reported from Cambodia (Bourret, 1942); recent records are from central Cambodia (Stuart and Platt, 2004).

Malayemys subtrijuga (Schlegel and Müller, 1844) (Vulnerable) (Fig. 13)

Captive adult [ZRC(IMG) 2.119a–b], 17 November 2006, and one carapace + skull, 1 February 2007, Koh Khnhaer Village; old remains (head only) [ZRC(IMG) 2.120] in local residence, Koh Rongnieu Island, 3 August 2007; captive juvenile [ZRC(IMG) 2.118], Kampong Dar Village, 11 August 2007. Both intact specimens agreed with Stuart et al. (2001) in having a brown carapace with three distinct keels, smooth margin and cream-yellow border, and a yellow plastron with black blotches. The intact head possessed the distinctive pattern of broad ivory lines above and below the eyes (Taylor, 1970). Residents stated that specimens had been caught locally. The adult (SCL 18.7 cm, SCW 14.2, PL 17.1 cm, mass 1 kg) was in the house of a wildlife trader who purchased it two days previously from a local fisherman. The juvenile (SCL 13.7 cm, SCW 10.0, PL 11.5, mass 303 g) belonged to a resident who caught it the same day in a fishnet, on Veal Prong floodplain. Sun et al. (2007) observed two captive individuals in Koh Khnhaer Village on 1 February 2007.

Historically reported from Cambodia (Bourret, 1942); recent records are mostly captive specimens from central-western Cambodia (Stuart and Platt, 2004).

Testudinidae

Indotestudo elongata (Blyth, 1853) (Endangered)

Fresh remains (plastron) [ZRC(IMG) 2.116] in local residence at confluence of Mekong/Prek Kandie Rivers, 15 November 2006; captive adult [ZRC(IMG) 2.117], Koh Khnhaer Village, 17 November 2006; old remains (plastron) in local residence, Koh Rongnieu Island, 3 August 2007. All specimens agreed with Stuart et al. (2001) in having an unhinged, elongate yellow plastron with black splotches in the center of each scute and (for the captive individual) rounded legs with large scales, a single large supracaudal scute over the tail and a brown carapace with black splotches. The captive adult (SCL 20.3 cm, SCW 12.5 cm, PL 18.3 cm, mass 1.1 kg) was in the house of a wildlife trader, who purchased it from a local fisherman in the previous two weeks. The Prek Kandie plastron (PL 17.5 cm) was reported by the owner to be from a specimen he caught in October 2006 near the riverbank while clearing land. The Koh Rongnieu plastron (not measured) was reported by the owner to be from a specimen caught in forest over 50 m from the riverbank. Five captive adults were observed in O Kak Village from 1–4 February 2007 by Sun et al. (2007).

Historically reported from Cambodia (Bourret, 1942); recent records are of captive specimens and the carapaces of hunted specimens, from the lowlands of eastern and south-western Cambodia (Long et al., 2000; Daltry and Traeholt, 2003; Stuart and Platt, 2004) and the Cardamom Mountains (Daltry and Chheang, 2000).

Trionychidae

Amyda cartilaginea (Boddaert, 1770) (Vulnerable) (Fig. 14)

Captive juvenile, confluence of Mekong/Prek Preah Rivers, 18 November 2006; captive adult [ZRC(IMG) 2.109a–c], 21 November 2006, and juvenile, 18 March 2007, in channel between Koh Khlap Island/riverbank; captive juvenile [ZRC(IMG) 2.108a–c] in channel between Koh Rongnieu/Koh Kring Islands, 30 July 2007; fresh remains (carapace) [ZRC(IMG) 2.111] and captive juvenile [ZRC(IMG) 2.110a–b], Koh Khnhaer Village, 17 November 2006. All specimens [SCL 13.1–37.5 cm, mean ± SD 24.1±8.9 (n = 6); SCW 11.7–30.1 cm, mean ± SD 19.5±7.1 (n = 5); PL 11.9–29.1 cm, mean ± SD 19.9±8.1 (n = 5); mass 0.24–6.1 kg, mean ± SD 2.5±2.7 (n = 6)] agreed with Cox et al. (1998) and Stuart et al. (2001) in possessing a row of prominent bumps along the anterior margin of the carapace and a slender snout. Most individuals were observed soon after residents

had removed them from fishtraps among submerged tree roots along forested riverbanks; one specimen had been caught on a fishing line. The Koh Khnhaer Village specimens were in the house of a wildlife trader who purchased them from local fishermen. Three carapaces (two in Koh Khnhaer Village and one in O Kak Village) were observed between 1 and 5 February by Sun et al. (2007).

Historically reported from Cambodia (Bourret, 1942); recent records are mainly of captive specimens in the Stung Treng Ramsar site (Timmins, 2006), Stung Treng Town market (Singh et al., 2006b), Virachey National Park in north-eastern Cambodia (Emmett et al., 2007), the Cardamom Mountains (Daltry and Chheang, 2000; Daltry and Traeholt, 2003) and lowlands of south-western Cambodia (Stuart and Platt, 2004).

Gekkonidae

Dixonius siamensis (Boulenger, 1899) (Figs. 15–16)

MVZ 258352, 11 November 2006, and MVZ 258351, 13 November 2006, Koh Rongnieu Island; MVZ 258353, 13 March 2007, and MVZ 258354, 16 March 2007, Koh Kring Island; MVZ 258355, 18 November 2006, and MVZ 258356, 18 March 2007, Koh Khlap Island.

Two males (TL 85.0, 88.4 mm; SVL 48.0, 48.6 mm; HL 14.0, 14.4 mm; HW 1.0, 1.9 mm; SE 0.5 mm) and three females [TL 85.9–111.4 mm, SVL 38.1–49.7, HL 1.0–1.4 mm, HW 0.9 (n = 1), SE 0.4 (n = 1)] mostly agree with Taylor (1963) in having a vertebral series of fine body scales flanked by 5–7 rows of enlarged, keeled scales that blend ventrally into large, imbricate, cycloid scales, ventral scales with minute posterior serrations, expanded subdigital lamellae at the tip of the digit only, subcaudals transversely widened, preanal pores in a curving or broadly angular series, numerous large black spots on the dorsum (rarely diffuse), tail banded dark and light, no black stripe from snout tip through eye to tail, lips strongly barred with cream and black. The number of preanal pores ('usually 6', Taylor, 1963: 750) was six (n = 3 females), seven (n = 1 female and 1 male) and eight (n = 1 male). Two colour morphs were observed, as reported by Smith (1935) and Taylor (1963): a dark morph, and a pale morph with little or no patterning on the dorsum except a dark canthal stripe extending from behind the eye to the back of the head.

A total of 36 individuals were observed (30 dark morph, six pale morph) including voucher specimens. All were among leaf litter or wood debris on the ground, either in seasonally exposed portions of the Mekong riverbed (n = 3), riverbank forest on islands (n = 12), or in mixed evergreen/deciduous forest over 50 m away from water on islands (n = 21). Individuals observed at night (1930–2200 h) were actively foraging while individuals detected in the day (0855–1553 h) were under wood debris. Two gravid females, each with two eggs, were found on 11 November 2006 and 16 March 2007. Adults and smaller individuals were observed in all seasons but only two hatchlings were recorded, on 20 March (dry season) and 29 July 2007 (wet season).

Previous records are from the Cardamom Mountains (Daltry and Chheang, 2000; Grismer et al., 2007a). *D. siamensis* is widespread in Thailand (Taylor, 1963). The similar *D. vietnamensis* was reported from hilly eastern Cambodia (Stuart et al., 2006).

Hemiphyllodactylus yunnanensis (Boulenger, 1903) (Fig. 17)

MVZ 258367, Koh Rongnieu Island, 13 November 2006; MVZ 258365–258366, Koh Khlee-ay Island, 20 March 2007.

One adult male (SVL 51.0 mm, HL 12.0 mm, HW 9.5 mm, SE 6 mm, IO 1.9 mm), one unmeasured adult male, and one adult female (TL 107.1 mm, SVL 52.3 mm, HL 11.9, HW 9.2 mm, SE 5.6 mm, IO 2 mm) agree with Taylor (1963) and Zhao and Adler (1993) in having four outer digits clawed and well developed, a vestigial (not expanded) inner digit of the hand, small granular dorsal scales lacking enlarged tubercles, ventral scales cycloid, vertical pupil, hind limbs that reach more than halfway between axilla and groin, a pair of enlarged postmentals, rostral nearly rectangular, with an entrant notch in its upper edge, subcaudals not strongly widened, and males possessing a distinct singles series of preanofemoral pores, transversely widened. Both males had incomplete tails.

MVZ 258367 was caught at 2130 h while foraging along a branch (2 m above ground) in a tree within the river, several metres from the bank and surrounded by shallow water, which had recently become exposed by receding waters. MVZ 258365–258366 were in a tree hollow 2.5 m above ground in riverbank forest (1025 h). The female was gravid with two eggs.

This is the second record of *H. yunnanensis* from Cambodia. Grismer et al. (2008b) documented a single female in hill evergreen forest in the Cardamom Mountains, *c.*350 km southwest from the present Mekong record and in notably different habitat.

Elsewhere in Indochina, *H. yunnanensis* is known in Laos from a single specimen in the mountainous north (Stuart, 1999). In Thailand, there are three specimens from Phu (= mountain) Kading in Loei Province (Taylor, 1963). Taylor (1963) reported this species also occurs in upper Myanmar and Yunnan, China.

Agamidae

Calotes mystaceus (Duméril and Bibron, 1837) (Fig. 18)

Eleven individuals were caught, identified and released (no voucher specimens), of which one, an adult male, was photographed [ZRC(IMG) 2.102]: Koh Khlap Island (n = 4), 20 November 2006; Koh Kring Island (n = 2), 8 August 2007; Koh Khlee-ay Island (n = 3), 20 March 2007. The adult male (TL 238 mm, SVL 74 mm, mass 11 gm) and the 10 other individuals agreed with Stuart et al. (2006) in having one or two spines above the tympanum, no spine at the posterior end of the supraciliary edge, and a deep oblique skin fold in front of the shoulder containing small, granular darkly pigmented scales. All individuals were observed in the day (0830–1314 h) in riverbank vegetation or mixed evergreen/deciduous forest with bamboo thickets over 50 m from water. Adults exhibiting courtship/territoriality behaviour (vigorous pursuits and bright skin colours) were observed on 20 November 2006 (early dry season) and 22 March 2007 (mid dry season). Three hatchlings (TL <11 cm) were observed from 6–8 August 2007 (wet season).

Other records are from hilly eastern Cambodia (Stuart et al., 2006) and the Cardamom Mountains (Daltry and Chheang, 2000; Stuart and Emmett, 2006); reported, but with no other details, from lowland forest in eastern Cambodia (Long et al., 2000).

Physignathus cocincinus Cuvier, 1829 (Fig. 19)

Ten individuals were observed, of which one was photographed and none were caught (no voucher specimens): adult, Koh Khlap Island, 20 November 2006; two adults, Koh Khlee-ay Island, 20 and 22 March 2007; juvenile, Koh Kring Island, 4 August 2007; adult, Koh Rongnieu Island, 22 November 2006; adult, Koh Sompong Thom island, 22 March 2007; two adults, channel between Koh Khlap Island/mainland, 16 March 2007; adult [ZRC(IMG) 2.103], channel between Koh Rongnieu/Koh Kring Islands, 30 July 2007; juvenile, channel between Koh Rongnieu/Koh Neang Hen Islands, 9 August 2007.

All individuals were observed at close proximity in good light, and had compressed bodies and tails, nuchal, dorsal and caudal crests (well developed in adults and weakly developed in juveniles), enlarged, white scales on the lower jaw, a nuchal fold, and green colouration with banding on the tail. Five individuals were observed at night (1900–2030 h), sleeping on branches 0.3–4 m above water along the forested riverbanks of islands (one juvenile was sleeping along a seasonal stream 200 m from the mainstream). The other five individuals were observed in the day (0845–1210 h) basking in riverbank vegetation. Adults were observed in all seasons. The two juveniles (estimated TL 40–55 cm) were observed in the wet season.

Previous records are from hilly eastern Cambodia (Stuart et al., 2006) and the Cardamom Mountains (Daltry and Chheang, 2000; Stuart and Emmett, 2006; Grismer et al., 2007a).

Varanidae

Varanus nebulosus Daudin, 1802

Four individuals were observed but not caught or photographed (no voucher specimens): all were seen along the channel between Koh Khlap/Koh Kring Islands, three on 7 August 2007 (over one kilometre of riverbank) and one on 8 August 2007. All individuals were observed at close proximity in good light using

8x42 binoculars, and the following diagnostic features were observed: nostrils close to snout tip, and uniform brown body with numerous small yellow spots which did not form any well-defined crossbars. These individuals were of four size classes (visually estimated in 2-foot increments then converted to metres): TL 0.3–0.6 m (1–2 ft), 0.6–0.9 m (2–3 ft), 0.9–1.2 m (3–4 ft) and 1.5–1.8 m (5–6 ft). All were observed in the day (0710–1235 h) basking on tree branches 2–15 m above the river, in trees located along the riverbank or partly submerged in the channel. This channel was the only site where *V. nebulosus* was observed during surveys.

Previously reported from lowland forest in eastern Cambodia by Long et al. (2000) and the Cardamom Mountains by Daltry and Chheang (2000) and Daltry and Traeholt (2003); their records, as with ours, were based on field sightings and/or dead specimens, rather than published voucher specimens.

Varanus salvator Laurenti, 1786 (Fig. 20)

Four individuals were observed, of which one was photographed and none were caught (no voucher specimens): fresh remains [ZRC(IMG) 2.104] of a large adult, Koh Kring Island, 3 August; adult, channel between Koh Khlap/Koh Kring Islands, 6 August 2007; juvenile, channel between Koh Khleng Por/Koh Tachan Islands, 10 August 2007; juvenile, Veal Prong floodplain, 11 August 2007. Two sets of unidentified varanid tracks were observed on sandbars along Koh Rongnieu and Koh Khleey-ay Islands on 13 November 2006 (early dry season) and 20 March 2006 (mid dry season).

The three live individuals were observed at close proximity in good light, with 8x42 binoculars, and the following diagnostic features were recorded: relatively long, depressed snouts and clearly demarcated yellow transverse bands across a dark brown-black dorsum. These individuals were of three size classes (visually estimated in 2-foot increments then converted to metres): TL 0.3–0.6 m (1–2 ft), 0.6–0.9 m (2–3 ft) and 1.2–1.5 m (4–5 ft). All were observed in the day (0945–1355 h). Two were basking in trees along the riverbank 0.5 and 6 m above the river. The juvenile at Veal Prong floodplain was basking 0.5 m above the water in a partly-submerged tree. The fresh remains of ZRC(IMG) 2.104 comprised the discarded feet, tail and stomach of an adult hunted and consumed by local residents. The stomach contents of this specimen comprised snake dorsal and caudal scales, prawns, bones, and fish scales and fins.

Field sightings and captive individuals were reported from lowland forest in eastern Cambodia (Long et al., 2000) and the Cardamom Mountains (Daltry and Chheang, 2000; Daltry and Traeholt, 2003).

Lacertidae

Takydromus sexlineatus Daudin, 1802

MVZ 258404 and MVZ 258405, Koh Kring Island, 13 March 2007. Two individuals (SVL 52.0–63.6 mm, HL 11.8–15.8 mm, HW 5.7–6.6, SE 5.1–6.9, IO 1.9–2.0, mass 3 gm each) had tail lengths 2.8–4.7 times longer than the SVL (tail tip missing in smaller individual), a single femoral pore, smooth (not keeled) head shields, four strongly keeled dorsal plates across the middle of the back which formed continuous lines, and one with ocellate spots on flanks and one without. MVZ 258404 was collected at 1005 h among dry grass and shrubs in riverbank vegetation 20 m from the river. MVZ 258405 was collected at 1133 h in dry bamboo thickets with thick leaf litter 300 m from the river. Five other individuals were caught and released, all on islands, in mixed evergreen or deciduous forest and bamboo thickets over 50 m from water, during the day (0844–1145 h). Adults were seen in all seasons (early dry, mid dry and wet) and two hatchlings (TL 80–150.4 mm) were observed on 4 and 8 August 2007 (wet season).

Previously reported from hilly eastern Cambodia (Stuart et al., 2006) and the Cardamom Mountains (Stuart and Emmett, 2006; Grismer et al., 2008b).

Scincidae

Lipinia vittigera Boulenger, 1894

MVZ 258369, Koh Kring Island, 17 March 2007. One adult (TL 94.6 mm, SVL 37.3 mm, HL 7.3 mm, HW 6.0 mm, SE 3.1 mm, IO 1.5 mm) matched the descriptions by Stuart et al. (2006) and Taylor (1963) in having an acutely pointed snout nearly twice the diametre of the eye, prefrontals in contact, two large preanals,

three distinct light-coloured (gold in life) longitudinal stripes along the back consisting of a vertebral stripe from snout tip to base of tail, a dorsolateral stripe from above the eye to tail, a black stripe flanking each light-coloured stripe, and a bright red-orange tail. This individual was seen at 1047 h, foraging 2 m above ground on the stem of a large *Ficus* tree, in mixed evergreen/deciduous forest 50 m from the riverbank. Four other individuals were observed (but not caught), foraging in the day (1155–1400 h) on tree branches 1–5 m above the ground in riverbank forest on Koh Khlap and Kring Islands, 12 and 14 November.

Previously reported from hilly eastern Cambodia (Stuart et al., 2006) and the Cardamom Mountains (Stuart and Emmett, 2006; Grismer et al., 2007a).

Lygosoma bowringi Günther, 1864

MVZ 258371, Koh Khlap Island, 20 November 2006; MVZ 258372 and MVZ 258373, Koh Kring Island, 13 and 17 March 2007.

Two adults (TL 90.2–110.8 mm, SVL 75.0–50.1 mm, HL 7.6–8.8 mm, HW 5.9–6.8, SE 2.9–3.5, IO 1.1–1.6 mm) and one juvenile (TL 66.0 mm, SVL 38.0 mm) match Taylor's (1963) description, with the distance between snout and arm-insertion contained 1.5 times in axilla-to-groin distance, adpressed limbs not touching, a pair of nuchals, lower eyelid scaly, 28–30 scales around body, paired frontoparietals, supranasals in contact, dorsal scales smooth, and a blackish dorsolateral line. Specimens were collected in thick leaf litter on riverbanks in mature secondary evergreen/deciduous forest. MVZ258372–258373 were foraging in the day (0846–1047 h) and MVZ258371 was collected at night (2000 h). Thirty-eight other individuals were observed, all during the day (0844–1629 h), on islands in the Mekong River, and all within leaf litter in riverbank forest (n = 15) or in evergreen/deciduous forest over 50 m from the river (n = 25). Twenty-five individuals (including voucher specimens) were caught and examined: three were gravid females each with two eggs (all seen in March, mid dry season), six were hatchlings (all seen in July-August, wet season), one adult had a small infestation of red mites in the axilla region, and three adults had regenerated tails.

Previously recorded from the Cardamom Mountains (Daltry and Chheang, 2000; Stuart and Emmett, 2006; Grismer et al., 2007a).

Sphenomorphus maculatus Blyth, 1853 (Fig. 21)

MVZ 258400, Koh Khlee-ay Island, 22 November 2006; MVZ 258401–258402, Koh Khlee-ay Island, 20 March 2007; MVZ 258403, Koh Kring Island, 13 March 2007. These specimens (SVL 36.0–56.9 mm mean ± SD 50.2 ± 0.5, n = 3) agree with Taylor (1963) and Stuart and Emmett (2006) in having a concave or flattened rostral, touching frontonasal, no nuchals, ear opening about size of eye, a pair of large preanals, limbs well developed, and pentadactyle, adpressed limbs overlapping. A total of 26 individuals were observed, including voucher specimens: all were foraging in the day (0918–1500 h) in leaf litter on sandy soils in riverbank forest. Adults were observed in all seasons but hatchlings (TL< 60 mm, n = 6) were only seen in the wet season (July-August). Twelve individuals (including voucher specimens) were caught and examined: none had mites or other visible external parasites and two had regenerated tails.

Recorded from hilly eastern Cambodia (Stuart et al., 2006) and the Cardamom Mountains (Daltry and Chheang, 2000; Stuart and Emmett, 2006); reported, but with no other details, from semi-evergreen forest in eastern Cambodia (Long et al., 2000).

Colubridae

Boiga cyanea (Duméril, Bibron & Duméril, 1854) (Fig. 22)

Single specimen [ZRC(IMG) 2.105a–c] measured, photographed and released, Koh Khlap Island, 17 November 2006. This adult male (TL 125 cm, mass 303 gm) agreed with Taylor (1965) and Stuart et al. (2006) in having enlarged vertebral scales, eight supralabials, one preocular, two postoculars, 21 longitudinal scale rows at midbody, and green upperparts. The chin was white with pale blue infralabials. It was caught at night (2215 h) 3 m above ground in a tree on the riverbank, in mature secondary evergreen forest. The tail tip was missing and old scars were present on the belly.

Recorded from central Cambodia (Saint Girons, 1972), hilly eastern Cambodia (Stuart et al., 2006) and the Cardamom Mountains (Saint Girons, 1972; Stuart and Emmett, 2006; Grismer et al., 2008b).

Chrysopelea ornata (Shaw, 1802)

Single specimen measured and released, Koh Enchey Island, 10 August 2007. This juvenile male (TL 81.0 cm, SVL 60.7 cm, HW 1.0 cm, mass 41.5 gm) agreed with Stuart and Emmett (2006) in having a bell-shaped frontal, one preocular, two postoculars, nine supralabials, fifth and sixth touching the orbit, last ventral and anal scale divided, and the top of head black with yellowish-green crossbars and spots and body scales green with a black margin and median line. It was caught at 1200 h on the riverbank in secondary forest. Two other *Chrysopelea* were observed with 8x42 binoculars in good light: one basking at 1047 h in a tree 10 m above the ground, in logged forest, Koh Norong Island, 20 March 2007, and one basking at 1210 h in a tree within the river channel between Koh Khlap and Koh Kring Islands, 1 m above water and 10 m from the riverbank, 7 August 2007.

Recorded from central Cambodia (Saint Girons, 1972) and the Cardamom Mountains (Saint Girons, 1972; Daltry and Chheang, 2000; Stuart and Emmett, 2006); reported, but with no other details, from dry deciduous forest in eastern Cambodia (Long et al., 2000).

Erpeton tentaculum Lacépède, 1800 (Fig. 23)

One female measured and released, Veal Prong floodplain, 11 August 2007; two freshly dead specimens, of which one was photographed [ZRC(IMG) 2.107], at Kratie Town market, 23 November 2006 (collected by C. Vidthayanon and deposited at Thailand Department of Fisheries). The wild female (TL 69.0 cm, SVL 49.5 cm, HW 1.1 cm, mass 90 gm) and two dead specimens (TL 62.9–87.3 cm; SVL 53.6–58.2 cm; sex not determined) possessed the two tentacle-like appendages extending from the rostrals unique to this species (Saint Girons, 1972). The female was caught at 1540 h in water among the branches of a partly submerged tree.

Previously recorded in the Tonle Sap Lake and floodplains around Phnom Penh, central Cambodia (Saint Girons, 1972; Stuart et al., 2000). Fishermen at the Tonle Sap Lake believe *E. tentaculum* is venomous and often discard live or dead individuals found in fishnets (Stuart et al., 2000). This species is largely confined to the Mekong Lowlands and does not occur in the Khorat Basin north-west of the study area (Karns et al., 2005).

Homalopsis nigroventralis Deuve, 1970 (Figs. 24–25)

MVZ 258368 (tail tip collected as tissue voucher, specimen released), Koh Kapeung Island, 21 March 2007; one adult measured and released, channel between Koh Khlap Island/mainland, 19 November 2006; juvenile (collected by C. Vidthayanon and deposited at Thailand Department of Fisheries), Koh Tongdaeng Island, 7 August 2007.

MVZ 258368 (adult, TL 98 cm, SVL 84 cm, HW 2.3 cm, mass not measured), the Koh Khlap adult (TL 104 cm, SVL 98 cm, mass 596 gm), and the juvenile female (TL 61.5 cm, SVL 46 cm, HW 1.8 cm, measured after one week in 10% formalin) mostly agree with Deuve (1970) (who described *H. nigroventralis* as a subspecies of *H. buccata*, Linnaeus) and Stuart et al. (2006) in having 11–13 supralabials and 15–16 infralabials (one adult had 10 supralabials and 14 infralabials), 35–38 longitudinal scale rows at midbody, 157–165 ventrals (160, 161 and 162 in our three specimens) and a dark venter with light spots. In life, the colour and patterns of these specimens closely matched the description by Stuart et al. (2006), including a light or dark olive venter in the adults, except that in one adult, the white chin marking was shaped as an incomplete rectangle extending to the first ventral.

MVZ 258368 was caught at 2115 h under 30 cm of water in a rock pool on the riverbank, sheltering within a thick mass of algae. The Koh Khlap adult was caught at 1945 h among low shrubs in the water along a muddy riverbank, and prior to capture was observed catching and killing a fish *Channa striata* TL 16 cm (Fig. 24). The juvenile was caught in early evening on an exposed, muddy riverbank (C. Vidthayanon personal communication).

This is the second record of this species for Cambodia. Stuart et al. (2006) first recorded *H.*

nigroventralis in rocky hill streams in eastern Cambodia, and treated *nigroventralis* as a separate species from *H. buccata* on the basis of colour, morphology and habitat.

Enhydris longicauda Bourret, 1934 (Fig. 26)

MVZ 258358, Kampong Dar Village, 5 August 2007 (collected by R.J. Timmins). This adult male (TL 49.3 cm, SVL 34.9 cm, HW 1.4 cm, measured after one week in 70% ethanol) with 21 midbody dorsal rows, 133 ventrals and 70 subcaudals agrees with reported scale counts for *Enhydris longicauda* by Murphy (2007) (ventrals 122–136, subcaudals 52–76) and Saint Girons (1972, for *E. innominata longicauda*) (ventrals 124–134, subcaudals 53–74). The dorsal scale row formula of this specimen is: 30 at first widened ventral, 25 at 10th ventral, 21 at midbody, and 19 before vent.

In most other aspects of scalation and colour this specimen matches descriptions of *E.i. longicauda* (Saint Girons, 1972) and *E. jagorii* (Taylor, 1965, see descriptions for *E. smithi* and *E. jagori*) in having nasals large and broadly in contact behind the rostral, rostral more than twice as wide as high, ventrals wider than lateral keels, dorsal scales smooth and distinctly larger posteriorly than anteriorly, parietals whole and touching, two or three postoculars one of which is the subocular, loreal touching internasal, eight supralabials, the fourth touching the eye and fifth and sixth touching the subocular, 10 or 11 infralabials (11 in this specimen), five touching the first pair of chinshields, which are nearly three times the size of the second pair, small head, distinct vertebral ridge, and possessing a mental groove. After one week in preservative the dorsum was grey with 64 blackish, pointed lateral bands extending from behind the head to tail tip, each 2–5 scales in width, and a dark grey belly scattered with pale spots.

This specimen was purchased from a local resident who reported she caught it in a fishnet on Veal Prong floodplain west of the Mekong River. The resident had a second specimen but this was not purchased (R.J. Timmins personal communication).

This appears to be the first record of *E. longicauda* outside the Tonle Sap Lake region of Cambodia, a range extension of *c.*200 km north. Cambodian specimens were collected by Saint Girons (1972: 118) at the Tonle Sap Lake and confluence of the Mekong/Tonle Rivers, who noted 'it would be interesting to know if the species occurs in the lower Mekong from Kratie to the delta'.

Three closely related and cryptic taxa, *E. longicauda*, *E. innominata* and *E. jagorii*, are reported from Cambodia, southern Vietnam and central Thailand respectively, and are distinguished principally on ventral scale counts and pattern (Murphy, 2007). *E. longicauda* is known only from Cambodia and was considered by Saint Girons (1972) to be a race of *E. innominata*.

Lycodon capucinus (Boie, 1827)

MVZ 258370, Koh Kring Island, 4 August 2007. This juvenile female (TL 29.6 cm, SVL 27.9 cm, mass 7 gm) conforms to descriptions by Taylor (1965) and Lanza (1999) by possessing: 19 midbody dorsal rows, paired subcaudals, smooth scales, nasals subequal, loreal in contact with internasal and not touching eye, flattened snout and head (snout projecting beyond lower jaw), rostral bent back over tip of snout, internasals much smaller than prefrontals, loreal more than twice as long as high, two postoculars and each in contact with a temporal, a white or yellow nuchal band, and purplish-brown above, with more or less distinct fine white or yellow reticulations.

This specimen was found at 1145 h under loose bark on the trunk of a dead standing tree, 1.5 m above ground, in mixed deciduous/evergreen forest, 10 m from a sandy seasonal stream and 200 m from the riverbank.

Taylor (1965) and Saint Girons (1972) treated *L. capucinus* as a full species while Lanza (1999) considered *capucinus* a subspecies of *L. aulicus* (Linnaeus 1758). *L. capucinus* was previously reported by a single specimen from central Cambodia (Saint Girons, 1972) and *L. aulicus* is listed in early herpetological collections from Cambodia in the 1800s (summarized in Bourret, 1936).

Oligodon sp.

Single individual measured and released, Koh Enchey Island, 22 November 2006. This individual (TL 37.5 cm, SVL 33.1 cm, mass 17 gm) had a grey-brown dorsum with two narrow

blackish longitudinal lines flanking a prominent vertebral ridge with small yellow spots, two blackish longitudinal dorsolateral lines, two broad, dark brown bands on the head, one extending from the prefrontals through the eyes to the supralabials and one from the crown to the base of the jaw but not reaching the ventrals, small mental groove, coral-red ventrals with irregular, black quadrangular markings, undivided anal plate, and 28 divided subcaudals. It was caught at 1000 h foraging among treeroots and leaf litter on a muddy riverbank in logged secondary forest. Upon capture the snake curled its tail tip, exposing the red ventrals.

The colouration and patterning of this individual matched the photograph for *O. taeniatus* Günther, 1861 in Cox et al. (1998:61), while its scalation closely matched the description by Taylor (1965) for *O. taeniatus*, although the number of divided subcaudals in this individual were fewer than reported for *O. taeniatus* by Taylor (1965) (30–47) or Campden-Main (1970) (32–48). The *O. taeniatus* group has recently been split into three species (David et al., 2008), and in the absence of a voucher specimen and further details of scalation, the present individual cannot be identified to species level.

Saint Girons (1972) reported *O. taeniatus* from central and south-western Cambodia. A single *Oligodon* sp. collected by Grismer et al. (2008b) in the Cardamom Mountains was subsequently assigned by David et al. (2008) to *O. deuvei*, one of the species they describe from the *O. taeniatus* group.

Xenochrophis piscator (Schneider, 1799)

MVZ 258406, channel between Koh Khlap Island/mainland, 19 November 2006; dead specimen (decomposed, not collected), Koh Dambong Island, 22 March 2007. A juvenile (TL 57.5 cm, SVL 39 cm, mass 41 gm) and a dead adult female (TL 90.2 cm, SVL 83.8) conform with descriptions by Taylor (1965) and Saint Girons (1972) in having 22–28 maxillary teeth, which gradually increase in size posteriorly, upwardly directed nostrils, internasals narrowed anteriorly to about one-third width of the scale, one large preocular reaching surface of head, outer posterior edge of ventrals greyish or blackish, diagonal lines from eye absent or very dim, and no black diagonal lateral stripe on neck tending to meet its fellow at nape. The juvenile has 132 ventrals and 85 divided subcaudals and the adult female had 143 and 21 respectively.

Table 4. Local reports of crocodiles, Mekong River, Sambor District, Kratie Province.

Sighting	Year	Latitude (N)	Longitude (E)	Local report
Crocodile	1950s	13°1'33"	106°4'46"	Prek Preah River. Shot 2 crocodiles, 1 km upstream from confluence with Mekong River
Crocodile	1950s	12°54'59"	106°00'13"	'Many' crocodiles but later hunted out due to skin trade
Nest	1950s	?	?	Near Bung Rum Lik Lake
Crocodile	1960s	12°58'20"	106°02'50"	1 crocodile, in deep pool in mainstream
Crocodile	1980	13°06'46"	106°03'11"	2 'small' crocodiles caught in fishnet
Crocodile	1984	13°00'30"	106°03'57"	2 'small' crocodiles caught in fishnet
Crocodile	1980s	13°01'37"	106°04'30"	5 'small' crocodiles caught in river & nest on bank nearby
Nest	1980s	13°01'37"	106°04'30"	Nest with 44 eggs on riverbank near above site
Crocodile	1990s	13°04'53"	106°04'03"	1 'small' crocodile for sale in Pontacheer village
Nest	2003	13°04'35"	106°02'45"	1 nest & crocodile between Koh Rongnieu & Khleng Por Islands (pers. comm. to R. J. Timmins)
Crocodile	2004	12°55'06"	106°00'13"	1 'large' crocodile & tracks (pers. comm. to R. J. Timmins)
Crocodile	2005	13°09'44"	106°01'00"	1 crocodile near Koh Amp Island (pers. comm. to R. J. Timmins)
Crocodile	2005	13°08'07"	106°01'46"	2± crocodiles between Koh Enchey & Koh Chroem Islands (pers. comm. to R.J. Timmins)
Crocodile	2005	13°08'55"	106°04'13"	1 crocodile near Koh Norong Island (pers. comm. to R.J. Timmins)
Crocodile	2005	13°10'37"	106°00'07"	1 crocodile (pers. comm. to R. J. Timmins)
Crocodile	2006	13°12'11"	106°02'04"	1 'large' crocodile seen in dry & wet seasons (pers. comm. to R. J. Timmins)

The ventrals of both specimens lack the black posterior border which is distinctive of *X. flavipunctus* (Zug et al., 2006). The juvenile was caught at 2015 h foraging in emergent shrubs along a muddy riverbank. The adult female was found drowned in a fishnet.

Saint Girons (1972) recorded this species in central and south-western Cambodia.

Viperidae

Calloselasma rhodostoma (Boie, 1827) (Fig. 27)

Single individual photographed [ZRC(IMG) 2.106] by P. Palee and J.F. Maxwell, Koh Rongnieu Island, 12 November 2006, and subsequently identified by the authors. This individual mostly agreed with Taylor (1965) and Cox et al. (1998) in having a prominent ridge from the eye to snout, an upturned and pointed snout, head grey-brown with a light, dark-bordered stripe on each side, dark, purplish-brown dorsum with paired, dark triangular markings (36 markings compared with 19–31 described by Cox et al., 1998). Observed at 1000 h in leaf litter on sandy soil in dry dipterocarp forest, 200 m from the riverbank.

Previously recorded throughout Cambodia (Saint Girons, 1972), hilly eastern Cambodia (Stuart et al., 2006) and the Cardamom Mountains (Stuart and Emmett, 2006).

Crocodylidae

Crocodylus siamensis Schneider, 1801 (Critically Endangered)

No crocodiles were observed during surveys. Some local residents reported the historic or continued presence of crocodiles, which probably refer to *Crocodylus siamensis*, the only crocodilian for which there are confirmed records in the Mekong River north of Tonle Sap Lake. Local reports were considered potentially valid if they were firsthand (described by the resident to the authors or R.J. Timmins), the resident could distinguish between a crocodile and varanid, and could provide a year and location. Sixteen reported sightings met these criteria, all from the Mekong River in the 'central section': 12 of wild crocodiles, one of a captive crocodile, and three nests (Table 4). Reported sightings were between the 1950s and 2006. Most residents appeared to have little awareness about crocodiles; of 23 interviewees (19 fishermen, three wildlife traders, one village head) only seven (five fishermen, one trader, one village head) claimed to have seen a crocodile. Interviewees had lived in the 'central section' for at least three years (mean 32 ± 24 SD, range 3–84 years) (mean age of interviewees was 48 ± 15 SD, range 32–84 years).

Three interviewees aged 84, 50+ and 66 years claimed crocodiles were 'common' in the study area until at least the 1950s and were frequently hunted for the skin trade from the 1950s–60s. Skins were sold to traders from Cambodia or Laos and the meat was eaten locally. Sale of crocodile skins was apparently an important cash source in the 1950s. Skins were dried or salted, then priced in 10 cm increments: in the 1950s, skin price was 5 Riel (USD0.001)/10 cm. Interviewees who had seen crocodiles stated only one form occurs (in Laos, some communities recognize different 'forms' based on colour or size, Bezuijen et al., 2006). None of the interviewees were aware of any cultural or medicinal practices involving crocodiles or their derivatives, and none had heard of any attacks on humans. The dialects of two local ethnic groups, P'nong and Khouey, have specific terms for 'crocodile', *ra-pu* and *pleo* respectively, distinct from the national Khmer term *kro-peu*.

The largest extant population of *C. siamensis* is in the Cardamom Mountains, although confirmed reports of scattered individuals persist in northern Cambodia, within 60 km of the study area, including an unknown number in the Stung Treng Ramsar site (5 km north of the study area), 1+ individuals in O Kandel River (50 km north-west) and 10+ in Se Kong River (60 km north-east) (Simpson and Han, 2004; Simpson et al., 2006a; Timmins, 2006). Infrequent migration may occur between the study area and these sites.

Discussion

Sixteen frog and 40 reptile species (17 snakes, 17 lizards, six turtles) were recorded during surveys. Species incidence curves suggest that surveys detected most frog species but did not detect all reptiles (Fig. 28) and additional species will probably be recorded in future surveys. Of

significance is the occurrence of six threatened turtle species (*Heosemys grandis*, *H. annandalii*, *Malayemys subtrijuga*, *Indotestudo elongata*, *Amyda cartilaginea*, *Pelochelys cantorii*), the second country records for a gecko *H. yunnanensis* and a snake *H. nigroventralis*, a range extension for another snake *E. longicauda*, and the possible extirpation of a crocodilian, probably *C. siamensis*.

Turtles, varanids and possibly some large snakes (e.g. *Broghammerus reticulatus*, *Ptyas* spp.) are the most threatened herpetofauna in the study area, due to unregulated hunting for commercial trade or local consumption. Turtles are the most commercially valued reptiles and all species recorded except *H. annandalii* were observed in trade (authors pers. obs; Sun et al., 2007). The low incidence of varanid sightings during our surveys (eight individuals and two sets of tracks in 45 days) suggests extreme wariness and/or low densities, presumably due to hunting. Residents consistently reported declines in harvests of large reptiles and some frogs and attributed this to increasing hunting. The study area lies within a region of well-organized wildlife trade, where locally-caught fauna is sold elsewhere in Cambodia, Laos, Vietnam and possibly China (Singh et al., 2006a, 2006b). Until recently habitat loss was not a significant threat to biodiversity in the 'central section' due to low human densities, but burning, logging and conversion of riverbank forest is now proceeding rapidly as communities colonise the area (Bezuijen et al., 2008) and this is causing new threats to herpetofauna.

The unconfirmed reports of crocodiles we collected suggest that a small number of crocodiles may persist, although any recruitment may be infrequent and insufficient to maintain local populations. Human disturbance is probably the principle factor suppressing recruitment because the 'central section' retains extensive suitable nesting and foraging habitat for crocodiles. It seems likely that any eggs or crocodiles encountered by local communities are kept, either for local consumption, commercial sale, or as 'curios'. *C. siamensis* forms large, obvious nest mounds and most waterways in the 'central section' are visited by local communities for fishing, increasing the likelihood nests are detected. In the 1990s, a crocodile nest with eggs was apparently found near Koh Khnhaer Village and the eggs were sold to a trader from Thailand (I. Saksang WCS Cambodia personal communication). Elsewhere in Cambodia, small numbers of wild crocodile eggs and hatchlings are purchased from local communities by national and foreign crocodile farms, and this is a significant threat to already small, scattered populations (SCWG, 2004; Jelden et al., 2005).

Three local residents independently reported the occurrence of another reptile, the turtle *Chitra* spp., which they referred to as *so-sai* and described as 'very rare' and 'large with patterns on the back'. Without prompting, they distinguished photographs of *Chitra* from *A. carti-*

Table 5. Comparison of herpetofauna richness at sites in Cambodia.

Location and habitat	Amphibians	Reptiles	Effort (days)*	Daily encounter rate (total spp./ days)*	Source
Cardamom Mountains (all areas): dipterocarp, evergreen forests (lowland, montane), modified habitats, 0–1,717 m asl	41	97	Several surveys	--	Grismer et al. (2008a) & references therein
Cardamom Mountains (south-eastern & central sections): forested hills, lowlands, riverine and modified habitats, 0–1,220 m asl	28	50	90	0.9	Stuart & Emmett (2006)
Eastern Cambodia: forested hills, streams, some agricultural habitats, 109–800 m asl	30	42	23	3.1	Stuart et al. (2006)
Eastern Cambodia, Mekong Plain: dry dipterocarp forest, seasonal wetlands, some agricultural habitats, 140–400 m asl	14	24	21	1.8	Long et al. (2000)
North-eastern Cambodia, Mekong Plain: Mekong River and floodplain, 20–50 m asl	16	40	45	1.2	Current survey

*Derived from survey effort cited in references.

Figure 2. Dry season riverine habitats in the 'central section'.

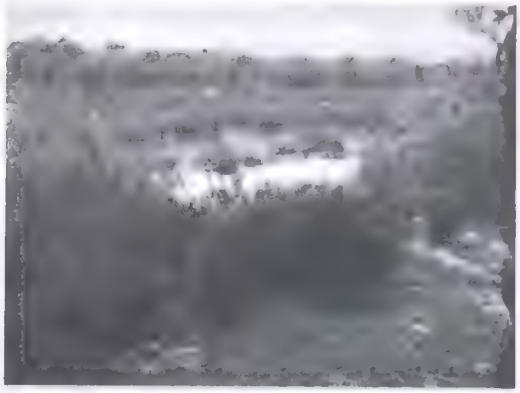

Figure 3. Dry season riverine habitats in the 'central section'.

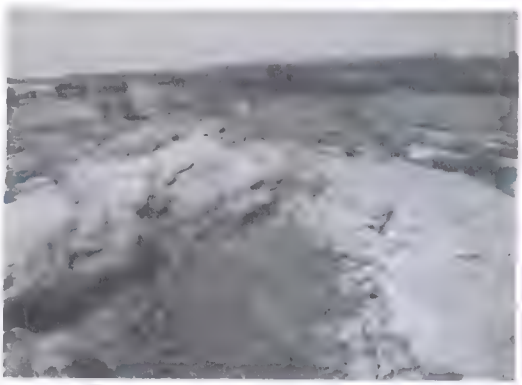

Figure 4. Dry season riverine habitats in the 'central section'.

Figure 5. Dry season survey campsite in riverbed, Koh Rongnieu Island, 'central section'.

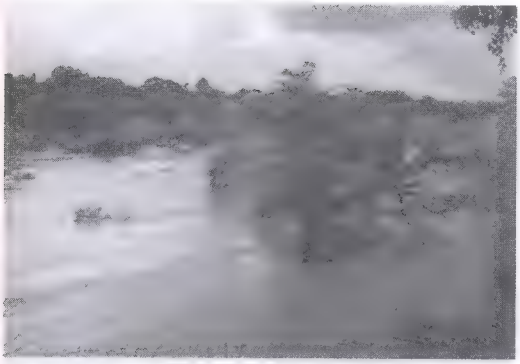

Figure 6. Mekong River in 'central section' in wet season. Dry season habitats are inundated.

Figure 7. Riverbank forest, dry season, and capture site of two *Hemiphyllodactylus yunnanensis*, Koh Khlee-ay Island, 'central section'.

Figure 8. Deciduous dipterocarp forest in wet season, Koh Rongnieu Island, 'central section'.

Figure 9. Adult *Glyphoglossus molossus* [ZRC(IMG) 1.30], Koh Kring Island.

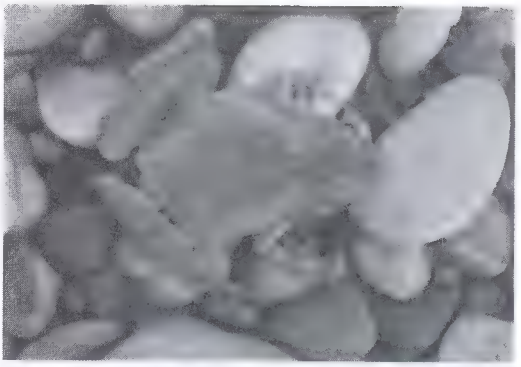

Figure 10. Adult male *Microhyla berdmorei* (MVZ 258378) in channel between Koh Khlap Island/mainland.

Figure 11. Adult *Heosemys grandis* [ZRC(IMG) 2.114], views of plastron and carapace, Koh Kring Island.

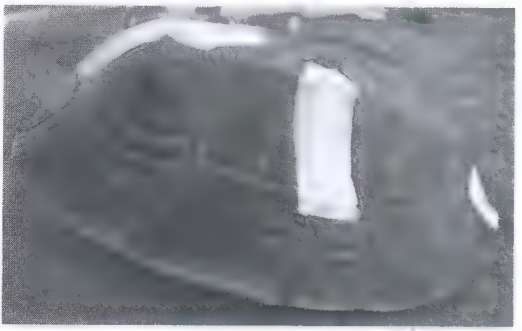

Figure 12. Adult *Heosemys annandalii* [ZRC(IMG) 2.112], views of carapace (preceding page, bottom right) and plastron, Koh Kring Island.

Figure 13. Juvenile *Malayemys subtrijuga* [ZRC(IMG) 2.118], captive, Kampong Dar Village.

Figure 14. Juvenile *Amyda cartilaginea* [ZRC(IMG) 2.108a–c] in channel between Koh Rongnieu/Koh Kring Islands.

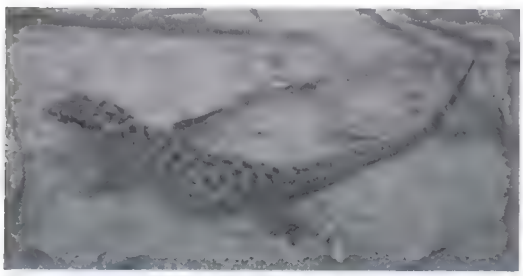

Figure 15. Adult female *Dixonius siamensis* dark morph (MVZ 258351), Koh Rongnieu Island.

Figure 16. Adult male *Dixonius siamensis* pale morph (MVZ 258355), Koh Khlap Island.

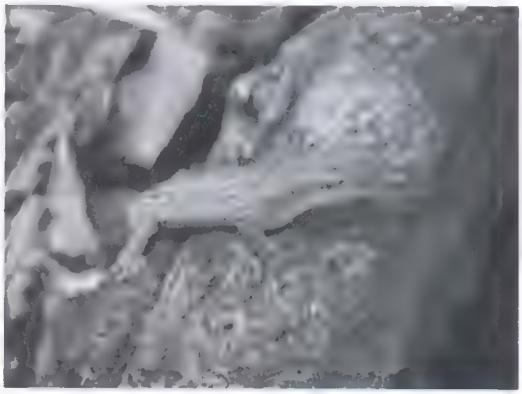

Figure 17. Adult male *Hemiphyllodactylus yunnanensis* (MVZ 258367), Koh Rongnieu Island.

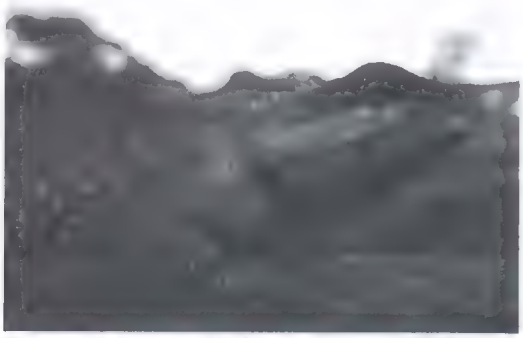

Figure 18. Adult male *Calotes mystaceus* [ZRC(IMG) 2.102], Koh Khlap Island.

Figure 19. Adult *Physignathus cocincinus* [ZRC(IMG) 2.103], channel between Koh Rongnieu/Koh Kring Islands.

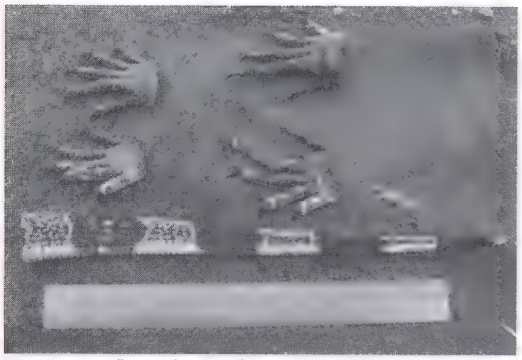

Figure 20. Remains of adult *Varanus salvator* [ZRC(IMG) 2.104], Koh Kring Island.

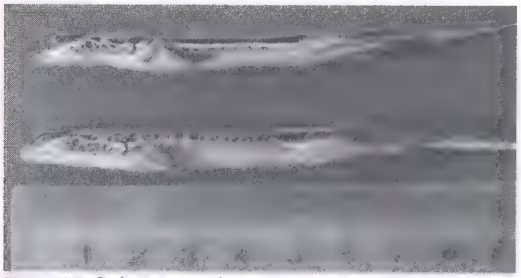

Figure 21. *Sphenomorphus maculatus* (MVZ 258401–258402), Koh Khlee-ay Island.

Figure 22. Adult male *Boiga cyanea* [ZRC(IMG) 2.105], Koh Khlap Island.

Figure 23. Adult *Erpeton tentaculum* [ZRC(IMG) 2.107], Kratie Town market.

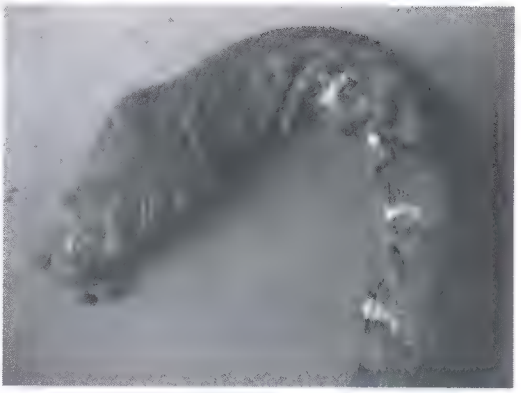

Figure 23. Adult *Erpeton tentaculum* [ZRC(IMG) 2.107], Kratie Town market.

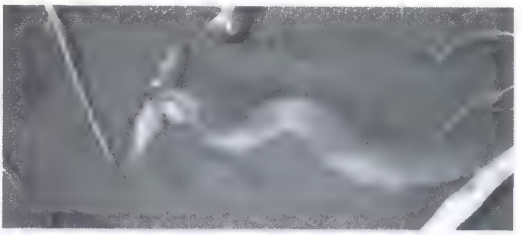

Figure 24. Adult *Homalopsis nigroventralis* catching a fish *Channa striata*, Koh Khlap Island.

Figure 25. Adult *Homalopsis nigroventralis* (same individual shown in Fig. 24).

Figure 26. Adult male *Enhydris longicauda* (MVZ 258358) with field tag, floodplain west of Kratie Town.

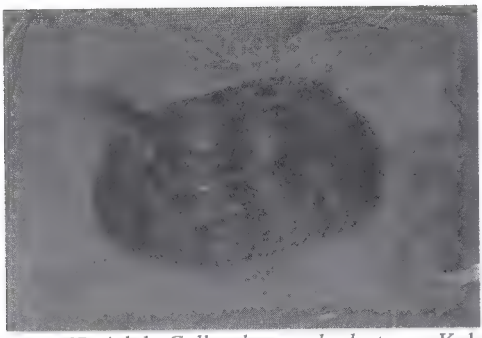

Figure 27. Adult *Calloselasma rhodostoma*, Koh Rongnieu Island (photo P. Palee).

laginea and *P. cantorii* and stated it is different from these latter species. In contrast, one 84-year resident, familiar with *A. cartilaginea* and *P. cantorii*, did not recognize photographs of *Chitra* and had never seen or heard of it. The genus *Chitra* is currently known from the Mae Klong and Chao Phraya rivers in Thailand (>600 km north-west of the study area), Peninsular Malaysia, and Java (Indonesia) (Thirakhupt and van Djik, 1994; Kitimasaki et al., 2005). If confirmed, the presence of *Chitra* in the Mekong River would represent a significant extension to the global range of this genus.

Seasonal differences in detection, standardized for survey effort, were apparent between our three surveys: our highest encounter rates were in the wet season (2.9 species/day; total 44 species) followed by the early dry season (2.7 species/day; 38 species) and mid dry season (1.9 species/day; 30 species). Fifteen species were only recorded in the wet season and six species were only recorded in the early dry season; all species recorded in the mid dry season were also recorded in other seasons.

Hourly species encounter rates between five quantified search methods were similar: quadrats (0.9 species/hour), day- and night-searches by walking (0.7/0.6), and day- and night-searches by boat (0.6/0.5). The most number of species recorded by a single method was in quadrats (27) and night-searches by walking (24), but all species recorded in quadrats were also collectively recorded by the other methods. Nine species were recorded only from captive specimens/remains and three species were only recorded in random encounters. We did not catch any turtles in 195 trap-days, but Sun et al. (2007), who conducted trapping in the same sites, caught one *P. cantorii* in 224 trap-days. All search methods, except quadrats and day-searches by walking, detected at least one species not found by other methods, despite initial detection rates being highest in quadrats. These results indicate the importance of utilizing a range of survey methods in the detection of amphibians and reptiles.

To assess the relative conservation importance of the study area for herpetofauna we compared species richness and composition with studies from other sites. Comparisons are limited due to differences between studies in sampling methods, effort and timing, but indicate the following. First, the majority (47%) of taxa we recorded in the study area are characteristic of anthropogenically modified environments (*sensu* Stuart and Emmett, 2006; Stuart et al., 2006) and occur elsewhere in Cambodia or Indochina (Table 3), indicating the study area has a relatively low global importance for most resident herpetofauna. Second, the riverine habitats of the Mekong Lowlands support a lower richness than mountainous or hilly regions of

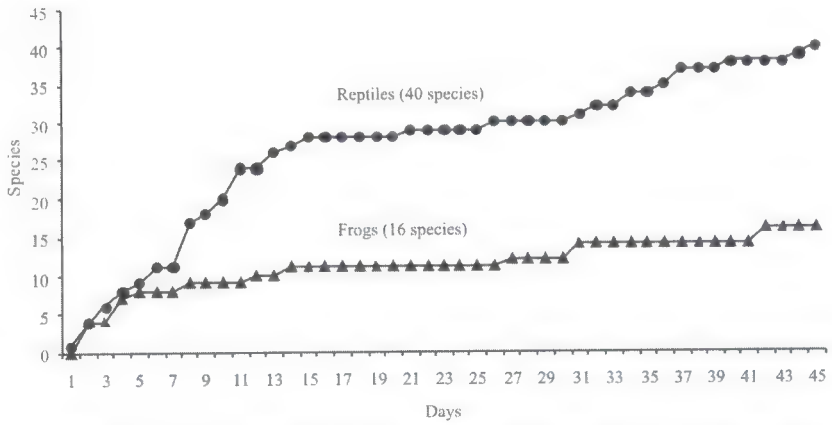

Figure 28. Species incidence curves for frogs and reptiles over 45 survey days, Mekong River.

Cambodia (Table 5). At least 94% of frogs, 67% of turtles, 94% of lizards and 53% of snakes we recorded in the study area have been recorded in the Cardamom Mountains and surrounding lowlands, which also support many additional species which do not occur along the Mekong River (see checklist in Grismer et al., 2008a). A smaller overlap occurs with hilly eastern Cambodia and lowland forests of Mondulkiri Province (which respectively support 63% and 69% of the frogs we recorded, 53% and 65% of lizards, and 17% for turtles in the lowland forests of Mondulkiri, Long et al., 2000; Stuart et al., 2006), although these areas have been subject to less collecting effort than our study area or the Cardamom Mountains (Table 5).

We conclude that the principle conservation priorities for amphibians and reptiles of the Mekong River in north-eastern Cambodia involve a relatively small subset of taxa which are not restricted to the Mekong Lowlands (except probably *E. longicauda*), but for which the lowlands support important populations. These include at least six turtle species, the snakes *H. nigroventralis* and *E. longicauda*, and potentially, the gecko *H. yunnanensis* and crocodilian *C. siamensis*. The remnant riverine and forest habitats of the study area contribute to the persistence of regional populations of these taxa and for at least some turtles are globally important. For *H. yunnanensis*, *H. nigroventralis* and *E. longicauda*, current threats in the study area may be small, although further information is required on the local status and distribution of these species. For the six turtle species, conservation efforts should focus on working with local communities to reduce hunting pressure, particularly in the 'central section'. A reduction in hunting might also result in the recolonisation of the study area by *C. siamensis*. Proposed management actions to reduce habitat loss and conversion in the study area (Bezuijen et al., 2008) would also benefit herpetofauna and other vertebrate taxa.

Acknowledgements

Surveys and export of specimens to the Museum of Vertebrate Zoology (MVZ) were granted under permits issued by the Fisheries and Forestry Administrations of the Cambodian Ministry of Agriculture, Forestry and Fisheries. Surveys were conducted under a project led by WWF Cambodia. Many people assisted with surveys and we sincerely thank them all. Teak Seng, Richard Zanre and Robert Mather coordinated surveys, and the WWF teams in Phnom Penh, Kratie and Vientiane provided logistical support. Bryan Stuart confirmed species identifications, provided field tags and organised museum cataloguing of specimens at MVZ. David Emmett provided advice for turtle surveys, commented on turtle species accounts and loaned turtle traps. Robert J. Timmins contributed crocodile records. Jennifer C. Daltry, Patrick David, Doug Hendrie, Rohan H.P. Holloway, Barney Long, Tim McCormack, John C. Murphy, Olivier S.G. Pauwels, Boyd Simpson, Harold K. Voris and George Zug provided references or technical advice. John C. Murphy and George Zug commented on species accounts for *E. longicauda* and *H. yunnanensis* respectively. Huy Keavuth (WWF Cambodia) prepared the map. Kelvin K. P. Lim catalogued the voucher photographs deposited at the Raffles Museum of Biodiversity Research. The draft manuscript was improved by critical comments from Bryan L. Stuart and L. Lee Grismer. Surveys would not have been possible without the knowledge and assistance of the local guides who worked with us. Surveys were funded by The Coca-Cola Company, Sida-Wetlands Alliance Programme and WWF Greater Mekong Programme.

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Note on predation of *Calliophis melanurus* Shaw, 1802 (Serpents: Elapidae) by *Scolopendra* sp.

The genus *Calliophis* Gray, 1834 is represented by four species in India, namely *C. beddomei, C. bibroni, C. melanurus* and *C. nigrescens* (Whitaker and Captain, 2004). Of these, *Calliophis melanurus* (Shaw, 1802) probably occurs in most of Peninsular India (except the extreme north-west), with definite records from Gujarat, Maharashtra, Karnataka, Kerala, Tamil Nadu and West Bengal (Whitaker and Captain, 2004); there is a single record from Dhar, Madhya Pradesh (Vyas and Vyas, 1981). Throughout its range, *C. melanurus* remains poorly known in terms of its natural history. Here, we take the opportunity to add data based on several individuals observed in Mumbai.

A total of 14 individuals were rescued from Marol Police Camp, Mumbai (19°7'31"N–72°52'76"E), between 2003–2007, around October to January between 1730–0730 h., indicating its nocturnal habits. The snakes were often found around human settlements or inside houses. Some individuals were found under boulders, amongst leaf litter with sympatric species such as *Lygosoma lineata* which probably forms a part of its diet. *Calliophis melanurus* is an active little elapid, attaining a maximum length of 380 mm. When disturbed, the snake curls its tail displaying its coral red belly and blue caudal scales. A timid snake in disposition, not inclined to bite when handled. Bites cause slight swelling and itching (Whitaker and Captain, 2004). However, an individual received five bites in Mumbai (due to an accidental breakage of the snake's tail) with no evident symptoms.

On 16 December, 2007 at ca. 2345 h., our attention was drawn towards a rustling movement in the leaf litter inside a garden in Powai, Mumbai (19°7'53"N, 72°55'13"E). On closer observation, we discovered that the sound was coming from a *Scolopendra* sp. which was dragging a *Calliophis melanurus* held between its mandibles. The snake's head was chewed and was badly damaged. The tail was curled up, displaying the prominent coral red ventral scales and vermillion caudals and was twitching. We observed the phenomenon for about 7 min., after which the centipede dragged the snakes in a crevice of a stone wall. The centipede measured ca. 130 mm. and the snake, ca. 160 mm.

Scolopendrans are voracious nocturnal predatory arthropods. They are even known to overcome and feed upon significantly larger vertebrate prey including microchiropeteran bats (Molinari et al., 2005) and mice. The report on the predation of *Calliophis melanurus* by *Scolopendra* sp. is noteworthy.

We would like to thank Ketan for drawing our attention towards the snake and Gavin Desouza for recording the coordinates.

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Preliminary Observations on the Diet of the Cane Turtle (*Vijayachelys silvatica*)

(with two text-figures)

The cane turtle (*Vijayachelys silvatica*) is a cryptic species, endemic to the Western Ghats, India (Vijaya, 1982; Groombridge et al., 1983; Moll et al., 1986). They are omnivorous and reported to feed on fruits, leaves, molluscs, beetles and millipedes (Moll et al., 1986). However, the ecology of the species is poorly documented. The only published report on the diet of the species by Moll et al. (1986), stated that 20–70% of their diet was composed of animal material.

Field surveys are being carried out in Indira Gandhi Wildlife Sanctuary (IGWS), Tamil Nadu and Parambikulam Wildlife Sanctuary, Kerala, both sites are located in southern India. Eighteen different individual cane turtles were encountered in 97 man hours of search from February 2006 to January 2008 in the study areas (Table 1). Usually when cane turtles are handled, they defecate (Moll et al., 1986). Hence, the feces of individual turtles were thus collected and dried under a 40 W incandescent lamp. The dried material was then examined using a 10X hand-held lens and separated into diet components of: molluscs, insects, millipedes, seeds, plant materials (other than seeds) and sand. Components of diet in individual faecal samples were scored as 1 – low, 2 – medium and 3 – high, based on the relative quantity of dried material found in each faecal sample. Whenever possible, direct observations were also made on the feeding of the turtles. Thirteen faecal samples collected from 11 individuals comprising six males and five females were examined, in which one male and one female were captured twice and they defecated during both the captures (Table 1). All faecal samples contained at least one identifiable prey item; 85% had insect remains and plant matter; 77% had sand; 69% had mollusc remains; 38% had millipede remains and 15% had seeds; 85% had unidentified remains. All dietary categories were found in both males and females, except millipedes, which were found only in males (Fig. 1). This is probably an artifact of small samples. Millipede remains are reported in the diet based on faecal examination made from one female cane turtle (Moll et al., 1986). The presence of sand in the faecal matter is probably due to accidental ingestion and/or feeding on earthworms, the remains of which would not be detected in dried faeces.

Direct observations were made on three (one male #9 and two females #5-6) radio–tagged individuals after locating them on the forest floor. *Ad-libitum* observations were made by a single observer located 8–10 m away from the animal so that it was not disturbed. At Karian Shola, IGWLS, on 27 November 2006 at 1430 h, an individual *Indrella ampulla* snail was found on the forest floor with froth covering its body, and about a foot away, male cane turtle #7 was observed. *Indrella ampulla* is a large terrestrial snail of the family Zonotidae, endemic to the Western

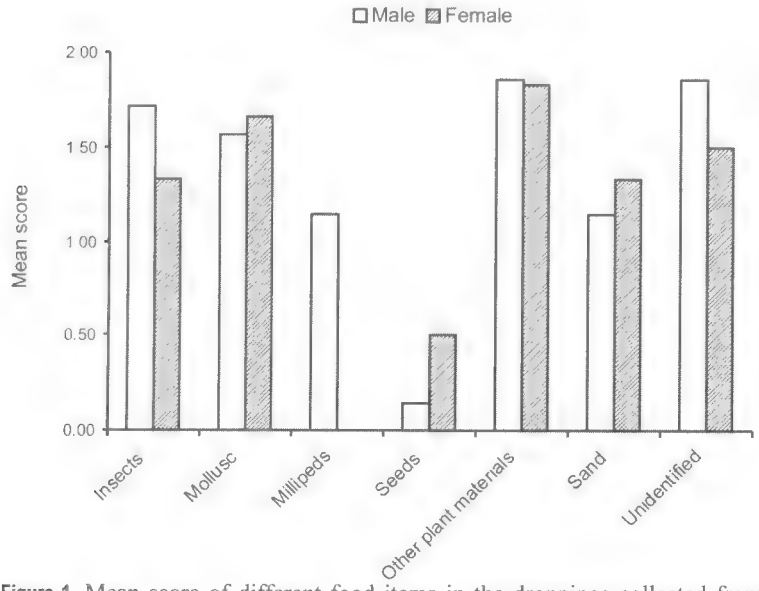

Figure 1. Mean score of different food items in the droppings collected from *Vijayachelys silvatica* from six males and five females.

Table 1. Details on individual cane turtles captured from different parts of the study area and their faecal samples used for the diet analysis. M = Male; F = Female; J = Juvenile; Y = Yes; N = No.

S.no	Turtle ID	Category	Date (dd.mm.yy)	Time	Locality	Elevation (m)	Faecal sample (Y/N)
1	1	M	02.06.06	11:10	Karian shola	770	Y
2	1	F	25.07.06	17:50	Anaikundhi shola	760	Y
3	2	M	09.08.06	14:45	Karian shola	770	N
4	3	M	09.08.06	14:52	Karian shola	770	Y
5	4	M	22.08.06	13:40	Anaikundhi shola	760	Y
6	5	M	29.08.06	18:00	Varagaliar shola	660	N
7	6	M	14.10.06	11:30	Karian shola	770	Y
8	2	F	07.11.06	16:35	Anaikundhi shola	760	Y
9	3	F	25.11.06	12:00	Karian shola	853	Y
10	7	M	26.11.06	14:30	Karian shola	770	Y
11	4	F	06.12.06	12:44	Karian shola	770	N
12	8	M	14.01.07	15:12	Karian shola	689	N
13	9	M	19.07.07	14:35	Karian shola	770	Y
14	5	F	31.07.07	18:35	Karian shola	770	Y
15	1	J	07.09.07	17:20	Karian shola	770	N
16	6	F	28.09.07	11:40	Karian shola	770	Y
17	2	J	30.09.07	09:15	Karian shola	770	N
18	10	M	15.01.08	15:30	Karian shola	770	N
19	9	M	17.02.08	11:00	Karian shola	771	Y
20	6	F	23.03.08	11:10	Karian shola	771	Y

Ghats (Blanford and Godwin-Austen, 1908). The turtle was immobile and had soil and litter stuck on the anterior part of its body. Upon close examination, it was observed that the carapace, head, forelimb and neck of the male turtle had sticky froth from the snail. It was inferred that the turtle had attempted to feed on the snail, and in response the snail produced an adhesive frothy secretion that stuck to the head, neck and limbs of the turtle. The mobility of the turtle was temporarily impaired. Other observations corroborating the fact that *Indrella ampulla* formed an important component of cane turtle diet were made on three different occasions. At Karian Shola, IGWLS, on 26 July 2007 at 1350 h and on 10 November 2007 at 1630 h male #9 was located with fragments of the land snail shell and froth within 10 cm from the turtle. On 12 February 2008 at 0945 h, female #6 fed on the land snail at the base of a tree trunk (Fig. 2). It was inferred that the froth secreted by the land snail was in defense from predation by the cane turtle. Production of sticky mucous as a defense against predators is well known in molluscs (e.g., Eisner and Wilson, 1970; Parkarinen, 1994; Mair and Port, 2002). The snails' mucous primarily helps them in navigation, surviving desiccation, providing structural support and locomotion (Denny, 1989). These observations confirm that *Indrella ampulla* is part of the cane turtle diet. It also suggests that *Indrella ampulla*

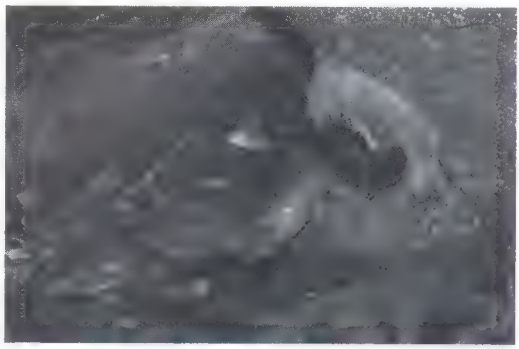

Figure 2. *Vijayachelys silvatica* preying upon *Indrella ampulla* snail on the base of a tree trunk.

has a unique mechanism that can deter predators, such as the cane turtle

Additional feeding observations were made on 2 August 2007 at 1230 h, female cane turtle (# 5) was observed feeding on *Diospyros buxifolia* fruits. It spent four days feeding under this fruit tree. On 12 October 2007 1040 h, female cane turtle (#6) was observed feeding on earthworm. Cane turtles are known to feed on fallen fruits in the wild (Vijaya, 1982) and on vegetables and fruits in captivity (Henderson, 1912; Vijaya, 1982).

Our findings are consistent with previous observations on cane turtle feeding habits reported by Moll et al. (1986), highlighting the importance of forest floor macro-invertebrates in the diet of the species.

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New data on the poorly known snake, *Xenelaphis ellipsifer* Boulenger 1900 (Squamata: Colubridae)

(with five text-figures)

Two species are known in the genus *Xenelaphis*- the relatively common Malaysian Brown Snake (*X. hexagonotus*) and the apparently rare Ornate Brown Snake (*X. ellipsifer*). The former species is found in a much wider geographic range, i.e. from Myanmar across continental south-east Asia, to the Greater Sundas (Sumatra, Java and Borneo) than *X. ellipsifer* which so far has been recorded from Borneo, Sumatra and West Malaysia (Malkmus et al., 2002).

Over a hundred years ago, Boulenger (1900) described *Xenelaphis ellipsifer* from "Pangkalan Ampat", in the head waters of the Sarawak River, based on one specimen captured in a fish trap (Fig. 1). The holotype is currently in The Natural History Museum, London (BMNH 1946.1.7.38). Since then, few authors have reported on the species. De Haas (1950) reported this species only from Borneo and Sumatra, and according to Stuebing and Inger (1999),

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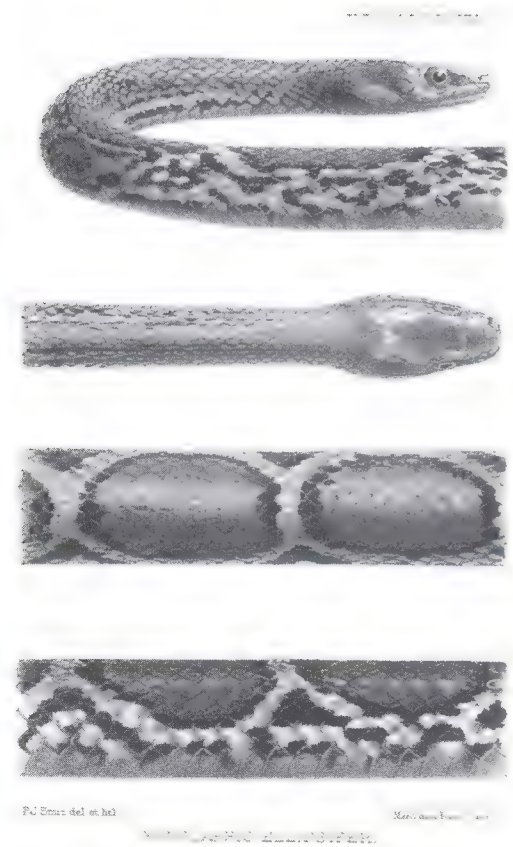

Figure 1. *Xenelaphis ellipsifer* illustrated in Boulenger (1900: Plate 16).

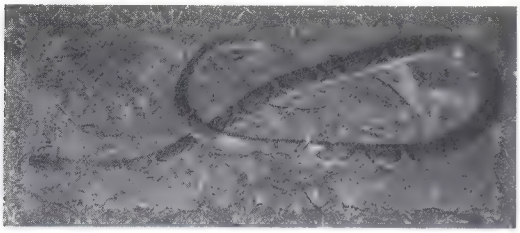

Figure 2. The rare *Xenelaphis ellipsifer* recorded in Gombak, Selangor, Peninsular Malaysia.

Figure 3. Lateral head view of *Xenelaphis ellipsifer*. Note the large eye and the square-like loreal scale.

Figure 4. Dorsal head view of *Xenelaphis ellipsifer*. Note the reddish brown colour and the protruding eyes.

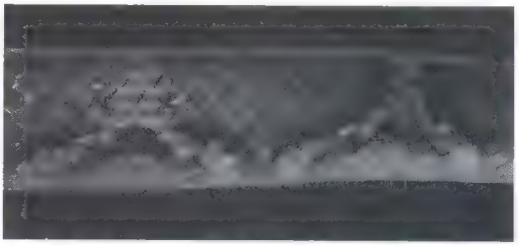

Figure 5. Colour pattern of lateral body of *Xenelaphis ellipsifer*. Note the inverted "Y" pattern and compare with Figure 1.

confirmed records for Borneo only refer to Sarawak. Tweedie (1953) only listed *Xenelaphis hexagonotus* native to the "Malay Peninsula", however in his third edition of this work, Tweedie (1983) stated that only six specimens have been recorded in Peninsular Malaysia.

This short note reports an additional record of *Xenelaphis ellipsifer* from Peninsular Malaysia, with new data on altitudinal range, morphometry, behaviour and presumably illustrates first photographs of the species.

Observations were made on 19 December 2007, between 2000–2100 h in the Gombak

Table 1. Comparison on morphometry, scalation and colour pattern from the holotype description of *Xenelaphis ellipsifer*, and the new specimen record from Gombak River.

	Boulenger (1900)	Gombak River specimen
Eye size	2x longer than distance to edge of mouth	yes, or less than twice distance from anterior eye to snout-tip (Fig.3)
Rostral	visible from above	only slightly visible from above
Internasals	almost equal length as prefrontals	slightly shorter than prefrontals (Fig. 4)
Frontal	1 and 2/5 long as broad, as long as its distance from snout-end and shorter than parietals	about same length as internasals and prefrontals together and longest distance approximately equal to widest distance of each parietal (Fig. 4)
Loreal	slightly longer than deep	almost squarish (Fig. 3)
No. preoculars	one, between 3rd and 4th supralabials	one large, below another smaller preocular, which resembles a subocular and fused with 3rd and 4th or 3rd and 5th supralabials (Fig. 3)
No. suboculars	two: one (large) below preocular, 1 (elongate) separating eye from 5th and 6th supralabials	two: a smaller one below preocular, another (elongate) which can either separate 5th and 6th , or 6th and 7th supralabials from orbit (Fig. 3)
No. postoculars	two	two, a "third" is located half in position of a postocular, but resembles subocular (Fig. 3)
No. supralabials	8	8
No. temporals	2+2	3+3, 2+3
Supralabials in contact with orbit	1	1, either 4th or 5th
No. infralabials	-	9–10
No. infralabials in contact with anterior chin shields	5; anterior chin shields shorter than posterior	5; anterior chin shields shorter than posterior
Colour pattern (head and neck)	pale brown, supralabials uniform yellow; neck with black longitudinal but interrupted markings	dorsal head more reddish than brown; supralabials yellowish with black markings, whitish infralabials without such markings (Fig. 3)
Colour pattern (dorsal body)	18 large elliptic, black edged brown areas separated by cream coloured, narrow interspaces	dorsally black framed (1–2 scale rows) brown areas elliptic to square-like in shape (Fig. 2)
Colour pattern (lateral body)	between and below the brown areas, cream-coloured, spotted or marbled with black	cream-coloured areas reflect a black framed inverted "Y" or "V"(Fig. 5)
Colour pattern (tail)	base like the body, second half uniform brown above with black lateral streak	second half not uniform brown, dorsally reflects elliptic olive brown areas framed by a thin dark line; streaks regularly interrupted; posterior sides and venter pinkish

River, ca. one hour north-west from Kuala Lumpur, in a primary forest enclave locked between roads and intersected by the Gombak River.

While scanning the river with torchlight, a long snake was detected, lying motionless in ca. 50 cm deep water. The current of this 10–12 m wide river stretch was relatively strong. When the snake was illuminated by the torchlight, it moved slowly towards the dark shelter of the overhanging roots at the edge of the river. The snake was secured, and measured 2.51 cm in total length, which exceeds published total length record of 2.32 m by Tweedie (1983). Images of this specimen are provided here (Figs. 2–5). To the authors' knowledge, no photos of this species have ever been published. Table 1 compares morphometric features, head scalation and colour pattern, with those provided by Boulenger (1900).

The specimen was recorded at ca. 150 m altitude, resembling a lowland forest habitat, rather than foothill or submontane forest habitats at 800 m and 1,000 m altitude, as was reported by Stuebing and Inger (1999) and Malkmus et al. (2002), thus representing a new altitude record for this species. Additionally, the specimen was detected active at night, and may therefore be

active at night, however, it cannot be proven if the specimen did not descend into the river due to our approach and may or may not have been active before. The exceptional large eye diameter may indicate crepuscular and nocturnal activity in a round-pupilled colubrid species. The specimen was released at its capture site.

The authors express their sincere thanks to Lim Boo Liat for his assistance in compiling the historical collection data.

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Life History Traits of Three Sri Lankan Scincidae, With Special Reference to the Reproductive Seasonality of *Lankascincus fallax*

The Scincidae of Sri Lanka is represented by 32 species belonging to eight genera, of which 24 species and the genera *Chalcidoseps* (Günther, 1872), *Lankascincus* Greer, 1991 and *Nessia* Gray, 1839 are endemic to the island (Wickramasinghe et. al., 2007; Batuwita and Pethiyagoda, 2008). The most unique are the nine relict taxa that belong to the subfamily Scincinae: *Chalcidoseps* and *Nessia* (Greer, 1970). Because of the fossorial habits of these species, their ecology is poorly understood. Species of *Lankascincus* (subfamily: Lygosominae) are commonly found in leaf litter and under stones and logs. Majority of the studies on Sri Lankan skinks relate to taxonomy and distribution (Taylor, 1950; Greer, 1991; Gans, 1995). Few studies have reported the reproductive habits of *Eutropis carinata lankae* (Deraniyagala, 1953), *E. macularia* (Blyth, 1853), *Dasia haliana* (Haly in Nevill, 1887), *Lankascincus taprobanensis* (Kelaart, 1852), *Lygosoma punctata* (Linnaeus, 1758), *Lygosoma singha* Taylor, 1950, *Nessia bipes* Smith, 1935, *Nessia burtonii* Gray, 1839 and *Nessia layardi* (Kelaart, 1853) (de Silva et al., 2005a; de Silva et al., 2005b; Deraniyagala, 1953; Taylor, 1950; Smith, 1935). The present communication deals with the reproductive habits of *L. fallax*, *L. deignani* and *N. monodacylus*. *L. fallax* and *L. deignani* are litter dwelling species. *L. fallax* is distributed throughout Sri Lanka, except at the highest elevations (> 1,000 m). However, *L. deignani* is a wet zone species whose distribution extends to the highest elevations. Both species are common in their ranges and do well in anthropogenic habitats. *N. monodactylus* is a limbless burrowing species which is distributed mainly at mid-elevations (300–1,000 m).

Gravid females were collected from the field and kept in captivity until they laid eggs. They were identified using diagnosis and descriptions given by Deraniyagala (1953), Taylor (1950) and Greer (1991). Lizards were kept in 29 x 21 x 13 cm plastic boxes supplied with a 5 cm thick

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Gravid females were collected from the field and kept in captivity until they laid eggs. They were identified using diagnosis and descriptions given by Deraniyagala (1953), Taylor (1950) and Greer (1991). Lizards were kept in 29 x 21 x 13 cm plastic boxes supplied with a 5 cm thick

layer of humus and water was sprayed at regular intervals to avoid desiccation. The skinks were fed with termites and earthworms. Measurements were taken using a vernier caliper to the nearest 0.1 mm (error ± 0.05 mm). Eggs collected from the field were kept until hatching, at room temperature (24–27°C). All females and hatchlings were released after taking measurements.

In order to assess the reproductive period of *Lankascincus fallax,* a survey was carried out from April 2005 to March 2006, in a 3-acre plot of land, situated in Ampitiya (550 m asl, Kandy District, Central Province). This site is an estate consisting of a mixture of Cocoa (*Theobroma cacao*), Nutmeg (*Myristica fragrance*), Cloves (*Syzygium aromaticum*), Pepper (*Piper nigrum*) and Coconut (*Cocos nucifera*). The site has both shady areas as well as open areas. The study site has thick leaf litter layer ranging from 3–6 cm. Once a month, *Lankascincus fallax* lizards were captured by hand through active searching within the study area during a 3-hour period and a number of gravid females in the sample was recovered. Gravid females with mature ova can be easily observed by external examination. Specimens of *L. deignani* were collected from Gannoruwa Forest Reserve (07°16'56.7"N, 80°35'54.0"E). The site consists of a dry mixed evergreen forest habitat with a thick leaf litter cover ranging from 4– 6 cm.

Lankascincus fallax (Peters, 1860)

Gravid females were observed throughout the year except in January and February. High numbers were observed from May to July, the highest being in July.

The snout to vent length of 14 gravid females ranged from 39.0–43.6 mm. While all gravid females had a white coloured throat, adult males had a black coloured throat with white spots. The clutch size consistently numbered two and the eggs laid in loose moist soil or under stones, logs or bricks about 2 cm below the surface. The eggs are chalky white and ellipsoid in shape. In a single clutch, the two eggs are buried in two different places. The mean length and width of 18 eggs were 9.67 mm and 5.23 mm, respectively (Table 1). The incubation period of 18 eggs belonging to nine clutches ranged from 39–45 days (mean 42.3). The snout to vent length of 15 hatchlings ranged from 14.5 mm to 17.3 mm (mean 15. 8 mm).

Lankascincus deignani (Taylor, 1950)

Three gravid females measuring 46.3 mm, 45.8 mm and 46.4 mm from snout to vent were collected from Gannoruwa Forest Reserve (Central Province, Kandy District) in June 2006. All of them laid two chalky white, ellipsoid eggs (8.9–9.3 x 5.3–5.6 mm) in the soil, ca. 2.5 cm under the surface. The eggs hatched after 42–46 days. The six hatchlings ranged in snout to vent length from 17.8–18.2 mm (Table 1).

Nessia monodactylus (Gray, 1839)

A female gravid *Nessia monodactylus* measuring 91 mm from snout to vent was collected from Gannoruwa Forest Reserve (Central Province) on 26 June 2006. It laid an elongated, pinkish-white egg, measuring 15.5 x 6.7 mm,

Table 1. Female size, egg size, hatchling size, and incubation period in some Sri Lankan skinks. See text for details.

Species	Mean female SVL (mm) ± SD	Clutch size	Mean egg size		Mean incubation period (days) ± SD	Mean hatchling size	
			Length ± SD	Width ± SD		SVL ± SD	TL ± SD
Lankascincus fallax	41.69 ± 1.36 (n = 14)	2	9.67 ± 1.86	5.46 ± 0.66	42.27 ± 2.08	15.84 ± 0.95	–
Lankascincus deignani	46.16 (n = 3)	2	9.07 ± 0.14	5.41 ± 0.11	44.50 ± 0.54	17.96 ± 0.16	21.01 ± 1.18
Nessia monodactylus	91 (n = 1)	1	15.5	6.7	42	46.0	19.0

on 19 July 2006, at a depth of ca. 3.5 cm from the soil surface. The egg hatched on 31 August 2006 and the hatchling was 65 mm in length.

The two species of *Lankascincus* studied show similar life history traits, dissimilar to that displayed in *Nessia monodactylus*. In the *Lankascincus* species, the clutch size was two. The eggs were incubated in room temperature between 24–29°C. This temperature range might not have an effect on the incubation period, given that the temperature of the microhabitat itself is also very close to these values. In any case, there were no sources to compare these values. However, in all three species studied, the incubation period ranged between 42 to 44 days. The average snout to vent length of gravid *L. fallax* was smaller than that of *L. deignani*. The average egg size of *L. fallax* was greater than that of *L. deignani*. According to Deraniyagala (1953), the eggs of *L. taprobanensis*, which is a montane species, are about 12.5 x 7 mm and eggshells have numerous fine longitudinal granular pleats. However, the average sizes of the eggs of *L. fallax* and *L. deignani* in the present study were much smaller. Nevertheless, the total length of the newly hatched young was 40 mm, which corresponds well to the values obtained in this study. The observation that the two eggs in the clutch of *L. fallax* and *L. deignani* are laid in two different places can have an adaptive significance and it has not been recorded in other skinks or other lizards before. This behaviour might be related to reducing mortality due to egg predation and/or other physical damage.

The periodic variation of the number of gravid females of *L. fallax* encountered strongly correlate with the seasonality of rainfall. The highest number of gravid females was encountered from May to August, which is also the time when the area receives rain from the Southwest monsoons. There is a complete absence of gravid females in January and February, which are the driest months. The reproductive cycles of tropical lizards can be continuous or seasonal, depending on a variety of factors, some of which are historical. In temperate areas, lizard reproduction is seasonal with mating and egg-laying often occurring from spring to summer (Fitch, 1970). However, tropical lizard species reproduce continuously in some areas (Inger and Greenberg, 1966) and seasonally in other areas where rainfall is seasonal (Clark and Alford, 1993). Lizards in Australian seasonal tropics show at least three patterns: (1) reproductive activity concentrated in the wet season, (2) reproductive activity concentrated in the dry season and (3) continuous reproduction (James and Shine, 1985). The results on the oviposition period obtained in this study show a close relationship with seasonal rainfall patterns in the study area. However, it is not adequate to confirm the relationship of egg laying period with the seasonality of rainfall for which the study should be extended over a longer period. Furthermore, reproductive period of *L. fallax* living in the dry zone can differ from this given that the seasonality of rainfall is different from that of the wet zone.

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The Rediscovery of *Enhydris pahangensis* Tweedie, 1946

(with one text-figure)

The rear-fanged water snakes in the family Homalopsidae (Colubroidae) were reviewed by Gyi (1970) and more recently by Murphy (2007). Gyi (1970) recognized 10 genera, containing 34 species, while Murphy (2007) listed 10 genera with 37 species, acknowledging that there are numerous undescribed taxa within this family. The genus *Enhydris* contains 24 species, but is paraphyletic (Alfaro et al., 2008). Two species (*Enhydris enhydris* and *E. plumbea*) are widespread, while the others are restricted to specific bioregions. In Peninsular Malaysia, six species of *Enhydris* are recognized (Das and Norsham, 2007). They are: *Enhydris bocourti, E. enhydris, E. indica, E. pahangensis, E. plumbea* and *E. punctata*. Of these, three are commonly found throughout Peninsular Malaysia (*E. bocourti, E. enhydris* and *E. plumbea*). *Enhydris indica*, *E. punctata* and *E. pahangensis* are poorly known, and *E. pahangensis* is known only from the type specimen.

Enhydris pahangensis was described on the basis of a single juvenile male from Kuala Tahan, Tembeling River, in the state of Pahang at an altitude of ca. 150–300 m, > 112 km from the east coast of Peninsular Malaysia (Tweedie, 1946).

In May 2007, a juvenile female was collected from the east coast of Peninsular Malaysia, in the state of Terengganu. The specimen was collected from a small stream in the Sungai Kura drainage, in the district of Hulu Terengganu (05°13'45.3'N, 102°28'17.5'E'), at an altitude of ca. 300 m. It was collected at night in shallow, murky and stagnant water. The stream had a muddy bed and was ca. 2 m wide. The surrounding area consisted of lowland secondary dipterocarp forests, undisturbed for many years. Tissue samples were taken and the specimen deposited at the herpetological collection of the National University of Malaysia (Catalogue number UKMHC 0923). This constitutes the second record for this species, and represents a

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Figure 1. Juvenile female *Enhydris pahangensis* (UKMHC 0923).

new locality record, extending its geographical distribution by over 100 km.

The specimen is a juvenile female, snout-vent-length 215 mm and tail length 50 mm. Eight supralabials, Supralabial IV touching the eye; nine infralabials, five of which are in contact with the anterior chin shields; 25 dorsal scale rows at midbody; 27 rows at neck; 20 rows near vent; 130 ventrals; 52 paired subcaudals and anal plate divided. The body is grey-brown above, with small dark spots over dorsum; a pale yellow stripe runs along each side of the body and covers first four lateral dorsal scale rows anteriorly and three rows posteriorly towards anus; this stripe wider and turns from pale yellow to white on sides of head and extends onto supralabials and rostral scale; lateral stripe bordered above and below by a dark, distinct zig-zag line; a dark median line runs between paired subcaudals; anterior portion of head, supralabials, infralabials and underside of head mottled with dark grey; ventral scales white. In Peninsular Malaysia, *E. pahangensis* differs from all other species of *Enhydris* in having 25 scale rows at midbody with the exception of *E. punctata* which has 23–27 scale rows; *E. pahangensis* can be readily distinguished from *E. punctata* by having eight supralabials while *E. punctata* has 12–14 supralabials.

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Python molurus Predation on a *Macaca nemestrina* in Khao Yai National Park, Thailand

(with two text-figures)

Pig-tailed Macaque (*Macaca nemestrina*) is one of five species of macaques found in Thailand, usually inhabiting inland evergreen or deciduous forest (Choudhury, 2003), where they can be found solitary or in large groups (McClure, 1964). Group size of this species ranges from 7–22 individuals (Borries et al., 2002). Although predation of primates is rarely observed (Uhde and Sommer, 2002), predation risk has been suggested as one of the major causes for the formation of large social units in most primate species (van Schaik, 1983). Pythons are represented by three species in Thailand, including the Reticulate Python (*Broghammerus reticulatus*), the Blood Python (*P. brongersmai*), and the Burmese Python (*P. molurus*). Burmese Python can be found in the forest plains and hills up to 900 m (Cox et al., 1998) and occasionally, near human habitations. Pythons are among the most commonly observed predators of wild primates, such as gibbons (Udhe and Sommer, 2002), macaques (Shine et al., 1998) and tarsiers (Gursky, 2002). The Burmese Python shows good camouflage, that permits prey to come close without detecting them, while they wait in ambush (Slip and Shine, 1988; Fredriksson, 2005).

In this paper, we describe a predation event by a Burmese Python on a Pig-tailed Macaque (*Macaca nemestrina*), in Khao Yai National Park (14°26'N, 101°22'E), in north-eastern Thailand, which covers ca. 2,200 km^2. This area (740 m asl) has mature, seasonally-wet evergreen forest (Brockelman et al., 1998; Kitamura et al., 2004). Pig-tailed Macaques are common at Khao Yai, where they often form large groups (> 30 individuals) along the roads, and near restaurants and camp grounds and near other housing within the Park, begging or stealing food from tourists (Huynen et al., in press). This area experiences heavy vehicular traffic and human movements.

In the afternoon of 11 January 2006, at the 109 Lodge of Khao Yai, 5 m from the main road, which passes through the Park's headquarters, we observed an adult female Pig-tailed Macaque being looped and squeezed by an ca. 2.5 m Burmese Python. At 1200 h, the macaque was squeezed against a small tree (ca. 6 cm diameter) where it presumably died. At 1330 h, the snake began swallowing its prey, head-first (Fig. 1), and it spent 30 min. swallowing this part. Then the python attempted to swallow macaque's shoulders, the widest part of the body (Fig. 2), but was unsuccessful. It then regurgitated the macaque and rotated the prey and started swallowing from the shoulders. It took the python 50 min. to completely swallowing the macaque at 1450 h. The python remained resting in the area for about 20 min., before retreating into a clump of bamboo. During the aforementioned event, there were two macaques walking and sitting on the roof of 109 Lodge, 20 m from the python without giving alarm calls. Several people were also present within 2 m,

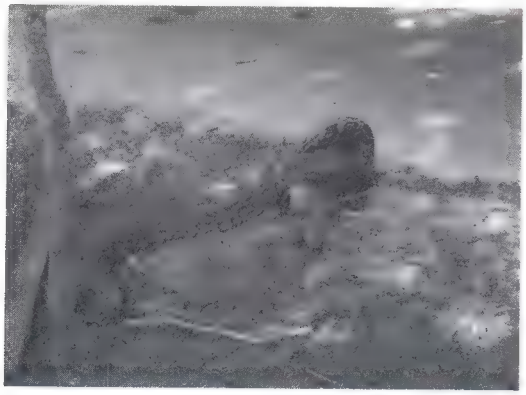

Figure 1. *Python molurus* (~ 2.5 m) starting to swallow a female *Macaca nemestrina*.

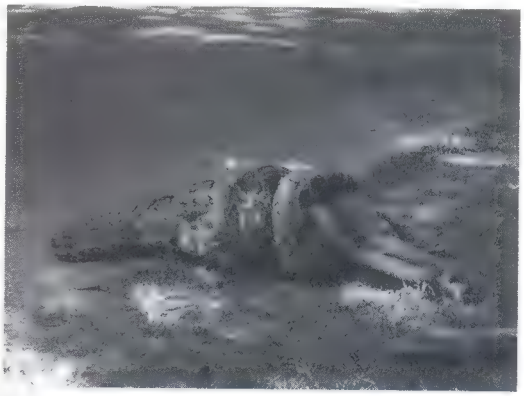

Figure 2. *Python molurus* swallows head, shoulders and feet of *Macaca nemestrina*.

which apparently had no effect on the snake's behaviour.

Although predation on macaques by the Reticulated Python has been reported before (Nettelbeck, 1995; Shine et al., 1998), this is the first detailed description of a predation event on a Pig-tailed Macaque by the Burmese Python. Overall, such predation events are rarely observed in the wild, and thus their frequency remains largely unknown, as no data are available for either Pig-tailed Macaques (Caldecott, 1986) or Pythons (Standford, 2002; Fredriksson, 2005). However, our observation confirms the existence of predation on Pig-tailed Macaque even in an area highly populated by humans where predation rates are assumed to be low due to the sensitivity of some larger predators to disturbance (Anderson, 1986; Berger, 2007). It is possible that a major distinction can be made between the types of predator in relation to their hunting and feeding behaviour. Primates are known to be predated by large carnivores, mainly felids (Davies, 1990; Isbell, 2005), for which diurnal primates tend to form large groups to increase the likelihood of detecting such predators (van Schaik and van Hooff, 1983). Complex mobbing behaviour is also a consequence of predator detection and isolation in group-living primates, as known in gibbons (Uhde and Sommer, 2002), White-faced Cebus Monkeys (*Cebus capucinus*) (Chapman, 1986); Spectral Tarsiers (*Tarsius spectrum*) (Gursky, 2002) and Bonnet Macaques (*Macaca radiata*) (Ramakrishna et al., 2005). Our observation also highlights the possibility that grouping is not a successful behaviour for other types of predators, such as large snakes, which are more difficult to detect. Pythons mainly hunt by ambush, relying on their camouflage to remain undetected in close proximity to potential prey. They are often reported to ambush at locations frequently used by wildlife (Slip and Shine, 1988). Under such circumstances, vigilance by large groups may be useless and, due to the large size of the prey, once one group member has been successfully attacked by a predator, additional mobbing is probably irrelevant. This might explain why surprisingly no mobbing was recorded by other macaques present at the predation site, in contrast to observations of smaller primate species such as tarsier, where other group members kept mobbing a python while it was ingesting its prey (Gursky, 2002). Overall, human presence did not appear to be a deterrent for this type of predator as during the event, a small crowd of people stood around to watch, and the python was not dissuaded from consuming the macaque once it began, unlike larger cats which can be deterred from finishing their prey relatively easily (Kerley et al., 2002).

It is unknown at this time whether pythons are commonly successful at depredating macaques or how the threats from pythons may stimulate anti-predator behaviour in this primate species. Furthermore, while Pig-tailed Macaques are relatively common in the Park (Jenks and Damrongchainarong, 2006) and elsewhere in southeast Asia (Azlan and Lading, 2006), the abundance of pythons is unknown, particularly those of sufficient size to capture an adult macaque. As these macaques may benefit from associating with humans in the park, further examination of predation rates on macaques far away from and adjacent to centres of human activity could be particularly useful for understanding the demographics of macaques in Khao Yai and elsewhere.

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Yawning in *Python molurus*

Yawning is widespread in many vertebrates, especially among homeotherms (Baenninger, 1987). Factors that reportedly stimulate yawning include psychological and physiological (see Gallup and Gallup, 2007). However, the precise reason and process for yawning is poorly understood. Experimental studies pertaining to yawning have largely been done on homeothermic vertebrates, especially humans. Reports on yawning in reptiles are scanty. In this paper, we report yawning in the free ranging Indian rock python, *Python molurus molurus,* in Keoladeo National Park (KNP), Bharatpur, Rajasthan, northern India.

Python molurus molurus, is listed as threatened and consequently protected under the Indian Wildlife (Protection) Act of 1972 (Anon, 2003), and is distributed in most parts of the Indian subcontinent from Pakistan to Bengal, and from the foot hills of the Himalayas to the tip of the Indian Peninsula and Sri Lanka (Smith, 1943). The Sálim Ali Centre for Ornithology and Natural History (SACON) in Coimbatore has been conducting ecological investigations on pythons in KNP since October 2007. In the winter (November-February), ambient temperature of the area falls to a low of 4˚C during the night, rising to ca. 23˚C by day. Due to the prevailing low temperature, pythons thermoregulate by basking (Bhupathy and Vijayan, 1989; Bhatt and Choudhury, 1993). We monitored the emergence of pythons from burrows, basking duration and their behaviour from 0900–1600 h (Indian Standard Time) from a hide (5 m above ground and 6–7 m from burrow). Individual pythons were identified using dorsal blotch pattern (Bhupathy, 1991) for monitoring and recording behaviour.

On 10 January 2008 at 1340 h, we observed yawning in a ca. 3.7 m female python at KNP. The ambient temperature and humidity during this time were 19.9°C and 48%, respectively. On 30 January 2008 the same python (identified based on dorsal blotch pattern and size) yawned at 1335 h. Temperature and humidity during this observation were 18.6˚C and 39%, respectively. On these observation days, the python that yawned emerged from earthen burrow at 1150 and 1120 h and retreated at 1500 and 1440 h, respectively. In both cases yawning occurred about 68–81 min prior to retreat. The yawning python opened its mouth vertically (90°), an action that lasted for 11 and 9 sec, respectively.

In general, yawning is reportedly contagious, but during these observations, two pythons (ca. 1.7 m in length) that were basking adjacently did not show this behaviour. A total of 58 contact hours with various pythons were made from November 2007 to February 2008, but yawning was observed only twice, which indicates the rarity of this behaviour in wild pythons. This particular individual was one of the largest (and presumably oldest) pythons observed during this study, and in general it appeared healthy. The duration of yawning in pythons (9–11 sec) is similar to that reported in humans (10 sec; Daquin et al., 2001). Yawning in the Indian rock python has not been reported earlier either in captivity or the wild.

Reasons for yawing in the python are not clear. In certain species yawning can serve as a warning signal (Tinbergen, 1952). But this may not be true in the present case, as no humans or animals were near the yawning python on both occasions. It is reported that in reptiles, some other activities may appear like yawning, such as the adjustment of jaw joints and bones after the dislocation due to the engulfing larger prey or consumption of slime-coated prey, such as fish, amphibians and snails (Kaplan, 2002). This may not be applicable in the present case as the python that yawned had no sign of previously consumed prey.

It is reported that yawning has a thermoregulatory function that evolved to promote or maintain optimal mental efficiency and homeostasis (see Gallup and Gallup, 2007). It is also reported that yawning may serves as a compensatory cooling mechanism when regulatory mechanisms fail to operate favourably. Low oxygen level in lungs may stimulate yawning, which involves opening the mouth involuntarily while taking a long deep breath of air. It is commonly believed that people yawn as a result of drowsiness or weariness or lack of sufficient oxygen. However, the function of a yawn to increase oxygen in the blood is found to be incorrect

(Provine et al., 1987). Yawning is commonly accompanied by stretching and occurs most frequently before sleep and after waking and may be associated with boredom. Robinson (1981) reported that yawning is significantly associated with head scratching in the black skimmer, *Rynchops niger*. Reasons for yawning in wild pythons, and for reptiles in general, remain unknown and merit further investigation.

This paper is an offshoot of the Python Project (20–28/2005 WL) sponsored by the Wildlife Division of the Ministry of Environment and Forests, Government of India. We are grateful to the Chief Wildlife Warden, Rajasthan, and Sunayan Sharma, Director of KNP for permission to undertake this study. We thank the Director, SACON for providing facilities and encouragements.

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A Mishmi Belief Concerning *Bufo cyphosus* from North-east India

(with one text-figure)

On 16 March 2005, I was on a trip to Mehao Wildlife Sanctuary, Lower Dibang Valley, Arunachal Pradesh, north-eastern India. The Sanctuary is within the Mishmi Hill Range. The local tribal people of the area are the Mishmis.

On that day, I was accompanied by Sito Mimi, my field assistant-cum-local guide. Sito (age ca. 46 years) belongs to Mishmi community and is a resident of Koronu village at the fringe of Mehao Sanctuary. We were turning over rocks, leaf litter and logs by the side of a forest trail near Koronu village, and at around 1230 h, I found a specimen of *Bufo cyphosus* Ye, 1977 (Fig. 1; specimen preserved in the Mu-

(Provine et al., 1987). Yawning is commonly accompanied by stretching and occurs most frequently before sleep and after waking and may be associated with boredom. Robinson (1981) reported that yawning is significantly associated with head scratching in the black skimmer, *Rynchops niger*. Reasons for yawning in wild pythons, and for reptiles in general, remain unknown and merit further investigation.

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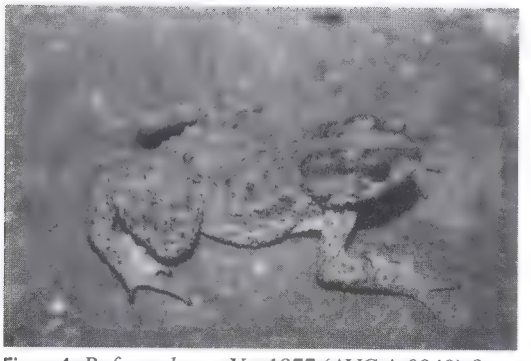

Figure 1. *Bufo cyphosus* Ye, 1977 (AVC A.0940) from Mehao Wildlife Sanctuary, Lower Dibang Valley, Arunachal Pradesh, north-eastern India.

seum of Arya Vidyapeeth College, Guwahati, Assam India, AVC A.0940), under a rotten log in a bamboo-dominated patch (GPS reading: 28°06'04.8"N, 95°54'29.2"E; elevation 350 m asl). As I collected the specimen and started to examine it, Sito Mimi burst out laughing, and after a while, stopped as suddenly.

Initially, I thought the reason for his merriment was my overt curiosity on the specimen. As soon as he stopped laughing, I asked him the reason for his exuberance. His reply was that, according to the Mishmis, one needs to laugh for a few moments (it should be loud enough for the *Bufo* to hear) when they come across any "*Pacapra*" (Mishmi for *Bufo*), as they believe God created this quirky creature to amuse us. He thus suggested me to enjoy this creature when I find it next!

I thank Annemarie Ohler for identification of the specimen.

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Notes on sexual size dimorphism and reproduction in the Asian Sand Snake, *Psammophis condanarus* (Psammophiidae)

Psammophiid snakes (comprising 7 recognised genera and ~50 extant species) are widespread and conspicuous members of the herpetofauna of Africa, southern Europe, the Middle East, and much of Asia (Schleich et al., 1996; Branch, 1998; Spawls et al., 2002; Khan, 2002; Kelly et al., 2008). Species belonging to the clade exhibit certain ecological characteristics considered uncommon among snakes in general (e.g., Dowling and Savage, 1960; de Haan, 2003; Shine et al., 2006; Cottone and Bauer, 2008a) and occur chiefly in regions of the world where few ecological studies of snakes have been conducted (Greene, 1997). The genus *Psammophis* (Sand Snakes) comprises approximately 60% of all species diversity within the family and these snakes are easily recognised throughout their distribution by their characteristic "whipsnake" morphology and behaviours (Schleich et al., 1996; Branch, 1998; Spawls et al., 2002).

As part of a broader study investigating sexual size dimorphism (SSD) in psammophiids, we dissected and measured specimens of the South and Southeast Asian species *Psammophis condanarus* (n = 27) from the collection of the California Academy of Sciences (CAS). This species occurs through Pakistan, India and Sri Lanka, extending northward to Nepal and eastward through Myanmar and Indochina into Indonesia (Ineich and Deuve, 1990; Prasad, 1992; Brandstätter, 1996; Ingle, 2004). Most information about the ecology of *P. condanarus* is based on general statements from regional works (e.g., Minton, 1966; Khan, 2002; Schleich and Kästle, 2002; Sharma, 2003; Whitaker and Captain, 2004) and little, if any, quantitative information currently exists on this topic.

Two subspecies are recognised, the nominotypical form from the area west of the Ganges Delta and *P. c. indochinensis* from southern Myanmar, through mainland south-east Asia, to Indonesia (Smith, 1943; Branstätter, 1996). The validity of the subspecific division of the species has not been critically assessed, so we have

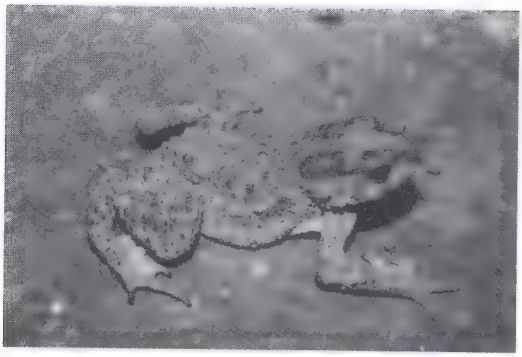

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Table 1. Descriptive statistics and results of two-tailed t-tests across sex in mean body traits for *Psammophis condanarus*. Data for body mass were ln transformed in order to meet the assumption homogeneity of variances, but unaltered means and standard errors are presented in the table.

	n:♂,♀	♂ mean ± s.e.	♀ mean ± s.e.	t	DF	P
SVL (mm)	21, 6	691 ± 4.3	560 ± 3.3	-1.591	25	0.124
Tail length (mm)	17, 5	206 ± 1.34	182 ± 2.48	-.866	20	0.397
Head length (mm)	21, 6	24.5 ± 0.88	21.9 ± 1.65	-1.41	25	0.171
Head width (mm)	21, 6	11.5 ± 0.50	9.81 ± 0.93	-1.580	25	0.127
Eye diameter (mm)	21, 6	3.97 ± 0.15	3.82 ± 0.28	-0.481	25	0.634
Body width (mm)	21, 6	14.1 ± 0.82	11.2 ± 1.53	-1.678	25	0.106
Body mass (g)	21, 6	116 ± 15.5	46.5 ± 29.0	-1.718	25	0.096

pooled the individuals examined here, most of which derive from Myanmar.

We recorded SVL, tail length, head length (from the posterior margin of the retroarticular process of the jaw to the tip of the snout), head width (at the widest point), body width (diameter at mid-body), eye diameter, and body mass (after draining and blotting to remove excess ethanol, e.g., Greene and Rodríguez-Robles, 2003) for each specimen. SVL and tail length measurements were taken to the nearest 1 mm with a string and metre rule, and all other measurements were taken to the nearest 0.1 mm with digital callipers. Analysis of tail length was based only on complete and unbroken specimens, which is especially relevant because psammophiids can autotomise their tails (Loveridge, 1940; Broadley, 1987; Akani et al., 2002; Cottone and Bauer, 2008b).

We used two-tailed *t*-tests to assess SSD in mean body traits and single factor ANCOVAs (with sex as the factor in each test) to assess differences in overall body shape across sex. All statistical analyses in this study were performed using JMP 4.0.2 (SAS) and SPSS (15.0). Data for body mass were ln transformed in order to meet the assumption homogeneity of variances. Our data show that males and females displayed no significant SSD in either mean body measurements (Table 1). ANCOVAs showed that there were no allometric differences across sex (Table 2).

The SSD index, which is negative if males are the larger sex (Gibbons and Lovich, 1990), was calculated to evaluate SSD patterns for *P. condanarus* within the context of its allopatric congeners. The SSD index for this species was -0.234.

Sex and reproductive status of snakes were determined by visual inspection of the gonads (located ~ 30–40 ventral scutes anterior to the cloaca). Of the 27 individuals sampled, 22% were female and 78% were male. All females examined (n = 6) were classed as mature because they displayed thickened muscular oviducts, and one with vitellogenic follicles was considered sexually active at the time of collection (CAS 222752, collected in January from Myanmar). None of the females examined had oviductal eggs.

Table 2. Allometric trends in *Psammophis condanarus*. Differences across sex were first evaluated by testing for homogeneity of slopes and then by single-factor ANCOVAs. Sex was used as the factor in all analyses.

Trait	Covariate	Homogeneity of slopes			ANCOVA		
		F	DF	P	F	DF	P
Tail length	SVL	0.055	1, 18	0.818	0.08	1, 19	0.928
Head length	SVL	0.022	1, 23	0.884	0.077	1, 24	0.784
Head width	Head length	1.580	1, 23	0.221	0.453	1, 24	0.507
Eye diameter	Head length	0.109	1, 23	0.745	0.589	1, 24	0.450
Body mass	SVL	0.100	1, 23	0.754	0.475	1, 24	0.497

All males examined (n = 21) were classified as mature and producing sperm at the time of collection, as testes were thick, enlarged, and turgid (as opposed to flat and ribbon-like) and for one specimen (collected in January from Myanmar) efferent ducts were also white and thickened (indicating presence of sperm). Finally, small incisions (~ 15 mm) were made at three different locations along the alimentary tract to check for prey items; none were detected for this sample.

While the sample size for this study is small, it is comparable to samples from other studies on psammophiids quantifying similar ecological parameters (e.g., Shine et al., 2006). According to these data, *P. condanarus* displays little sexual dimorphism in body size and shape, a pattern also seen in several psammophiids from Africa and Europe (Corti et al., 2001; Shine et al., 2006; Cottone and Bauer, 2009). Males do tend to have larger mean body traits, but the differences are not statistically distinguishable and may be misleading considering the skewed sex ratio of our sample. Moreover, sex ratios above 70% (male) have been reported in samples of other psammophiids (Shine et al., 2006) and may reflect underlying behavioral differences affecting capture frequencies.

Of the 13 congeners where SSD indices are known (Shine et al., 2006; Cottone and Bauer, in press, in press), *P. condanarus* is the most heavily male-biased of all, yet there were no statistically significant differences in mean size and shape here (Table 1 and 2); however, it is possible larger, more robust samples in the future may reveal otherwise. Interestingly, females have previously been reported to grow to larger sizes than males (Smith, 1943) and also account for the largest specimen measured for the species. These discrepancies highlight the importance of obtaining representative samples, especially since many psammophiids have widespread distributions and have been documented to exhibit geographic variation in several ecological traits (e.g., Marx, 1988; Kark et al., 1997; Cottone, 2007). Eighty-five percent (n = 23) of the specimens examined in this study were collected in Myanmar. Of the rest, one was collected in India, a second from Thailand, and two more from unknown localities. *Psammophis condanarus* occurs over a heterogeneous habitat, ranging from the arid deserts of Pakistan to the tropical monsoon climate of Myanmar and Indonesia (Brandstätter, 1996). It is likely that different habitats favor different ecological strategies and a more comprehensive investigation of *P. condanarus* could potentially reveal such differences.

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Field Observation of a Large Prey Item Consumed by a Small *Cylindrophis ruffus* (Laurenti, 1768) (Serpentes: Cylindrophiidae)

(with one text-figure)

Cylindrophis ruffus is a semi-fossorial, nocturnal and relatively common snake, widely distributed in the lowlands of south-east Asia. It is frequently found in the vicinity of rice paddies, ditches, canals, and gardens, will swim readily, and is reported to prey principally upon snakes and eels (Tweedie, 1954; Taylor, 1965; Saint Girons, 1972). Snakes of the families Cylindrophiidae and Aniliidae are among the most morphologically primitive of extant snake species, and feed almost exclusively on elongate lower vertebrates, which are sometimes heavy relative to the snakes (Greene, 1983). The diet and feeding habits of these snakes is of particular interest in the evolution of snake feeding mechanisms for large prey, yet there are few dietary observations from wild individuals, and most available data are from museum specimens and captive individuals. Here, I report a field observation of the consumption of a relatively large and heavy prey item, a swamp eel *Monopterus albus* (Zuiew, 1793), by a small individual of *C. ruffus*. I follow Adler et al. (1993) in using the specific spelling *ruffus* instead of the unjustified emendation *rufus*.

On 13 July 2006 at 1920 h, I observed and caught a juvenile *C. ruffus* on a path among rice paddies and scrub in a suburban district of Vientiane, the capital of Lao People's Democratic Republic (hereafter 'Laos'), and made the following measurements of this individual: female (ascertained by the absence of hemipenes), total length (TL) 293 mm, snout-vent length (SVL) 284 mm, head width (to the commisure of the jaws) 7 mm, mass 15.0 gm (measured with a Pesola 50 gm balance to 0.5 gm, after regurgitation of the eel), capture locality, 17°58'N, 102°36'E, elevation 165 m. This individual conformed to the description of Taylor (1965) for *C. ruffus* in having a cylindrical body of nearly equal diameter throughout, smooth scales, ventrals feebly enlarged, body scales small, imbricating and subequal, nasals in contact behind the rostral, and loreal and preoculars absent. It possessed the iridescent colouration distinctive of hatchling and juvenile *C. ruffus*. Upon capture the snake pressed its tail tip against my hand and flashed its red subcaudal scales (the latter is a common defensive reaction of *C. ruffus*: Campden-Main, 1970; David and Vogel, 1996).

Within five minutes of capture the snake regurgitated an eel, *M. albus*, with TL 240 mm, mid-body width 8 mm and mass 10.0 gm. The eel was visibly large compared to the snake (Fig. 1) and was equivalent to 67% of the snake's mass and 85% of its SVL. The eel was disgorged tail first, indicating it had been swallowed head first (consistent with feeding behaviour previously documented in *C. ruffus*: Greene, 1983; Cundall, 1995; Kupfer et al., 2003). The eel was identified by the absence of scales and pectoral and dorsal fins, features distinctive to this species (Kottelat, 2001).

This record is consistent with other published records that indicate *C. ruffus* consumes heavy vertebrate prey relative to individual snake mass. Three ratios help express size relationships between snakes and their prey: weight ratio (prey mass/predator mass) and ingestion ratio (prey diameter/snake's head diameter) (Greene, 1983), and length ratio (TL of prey/SVL of snake) (Jackson et al., 2004). Few published data are available for *C. ruffus* for any of these measures.

In the present record, the weight, ingestion and length ratios between the *C. ruffus* and eel were 0.67, 1.1 and 0.85, respectively. Values of 1.0 or greater indicate the prey item is equal to or greater than the snake's weight, head width or SVL respectively. By comparison, weight ratios of 0.01–0.83 (mean 0.24) were documented for nine *Cylindrophis* and their prey by Greene (1983), and values of 0.48 and 0.45 were recorded for two *C. ruffus* which had caught caecilians (Kupfer et al., 2003). These are the only other published weight ratios I am aware of for the genus *Cylindrophis*. The present value 0.67 is at the higher end of this range and reflects the large mass of the eel compared with the relatively small mass of the *C. ruffus*; in Greene's sample, the low values indicate that large *Cylindrophis* also consume small prey. In the case of *C. ruffus* and the eel *M. albus*, which attain maximum

Figure 1. Juvenile *Cylindrophis ruffus* (SVL 284 mm, mass 15.0 gm) with recently disgorged eel *Monopterus albus* (TL 240 mm, mass 10.0 gm), Vientiane, Laos.

lengths of 870 mm (David and Vogel, 1996) and 875 mm (Kottelat, 2001) respectively, it seems likely that both juvenile and adult *C. ruffus* will consume small and large eels.

The present ingestion ratio 1.1 is low (reflecting the elongate shape of the eel compared with the snake's gape) and the length ratio 0.85 is high (reflecting the eel's long TL compared with the snake's SVL). This length ratio is similar to the highest length ratio (0.88) measured for *C. ruffus* by Greene (1983), in which the prey item was also an eel. Cundall (1995) observed an unsuccessful attempt by a captive *C. ruffus* to eat a snake longer than itself (i.e., weight and length ratios > 1.0). It is unknown whether *C. ruffus* is able to ingest prey with weight or length ratios > 1.0.

By comparison, weight and/or length ratios > 1.0 have been documented in macrostomate snakes, including elapids and viperids, in which snakes consume prey heavier than themselves or longer than the length between their mouth and cloaca, and employ mechanical strategies to do so (Greene, 1983; Jackson et al., 2004 and references therein).

The choice of prey consumed in the present record, an eel, is consistent with other field data on the diet of *C. ruffus*. Greene (1983) examined museum specimens and also summarized published dietary records for *Cylindrophis* up to the early 1980s. He found that snakes and eels were the dominant prey items in the stomach contents of 30 specimens of *C. ruffus* collected from localities across south-east Asia.

An historical field record not cited by Greene (1983) is that of Smith (1921:196–197), who observed a *C. ruffus* consuming a *Xenochrophis piscator,* and noted 'it was firmly caught by the neck.. So tightly was it held that it required considerable force to extract it'.. [*C. ruffus*] 'feeds, as far as I know, upon eels and other snakes, and several specimens that have been sent me have disgorged meals, nearly as thick as, and several inches longer than, themselves'. Dietary field records subsequent to Greene (1983) are from Thailand, where Kupfer et al. (2003) observed two *C. ruffus* preying upon caecilians *Ichthyophis* cf. *kohtaoensisi*, and Karns et al. (2005) documented snake-feeding by *C. ruffus* among semi-aquatic snake communities (but provided no other details). Voris and Murphy (2002) noted that ophiophagus snakes such as *C. ruffus* are important predators of homalopsid snakes. Captive *C. ruffus* have been observed to consume snakes, salamanders, fish and small mice (Green, 1983; Cundall, 1995).

Much of central and southern Laos, including Vientiane, is located on large floodplains of the Mekong River and supports degraded suburban wetland habitats and rice paddies, where *C. ruffus* is common (Deuve, 1970; M. Bezuijen, unpubl. data) as is the eel *M. albus* (R. Mollot, pers. comm.). Given the similarity of these floodplain habitats with contiguous areas of north-east Thailand and Cambodia, it seems

likely that *C. ruffus* on Laos floodplains share similar dietary characteristics with these other regions of the Lower Mekong Basin.

I thank Roger Mollot for identifying the eel and David Cundall and Bryan L. Stuart for providing references. The manuscript was improved by critical comments from David Cundall, Tzi Ming Leong, John C. Murphy, Bryan L. Stuart and one anonymous reviewer.

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Handbook on Himalayan salamander

By Kaushik Deuti and V.D. Hegde
2007. Nature Books India, 6 Gandhi Market,
Minto Road, New Delhi 110 002, India.
iv + (4) + 43 pp., Plates I–XII.
Hardcover. No ISBN indicated. Price: Rs. 250.00.

Salamanders are typically amphibians of temperate zones. Europe and America have numerous species and Asia far fewer, though it has two of the largest, the amazing giant salamanders of China and Japan.

India has only one species of salamander (or newt, another name for these lizard-shaped amphibians), the Himalayan salamander (*Tylototriton verrucosus*), confined to the hilly regions of northern West Bengal and north-eastern India. This unique creature is under serious threat and it is excellent that Zoological Survey of India herpetologists Deuti and Hegde have come out with this popular, scientifically accurate illustrated account.

The text of this Handbook is a compilation of what has already been studied and recorded about the Himalayan salamander in scientific journals plus the author's own recent field observations. We now have a fairly good idea of the life history, breeding biology, distribution and status of the species and the authors clearly state the threats it is facing with their suggestions for its conservation.

Further field work may show that the species has a larger range, but much of its former habitat has been converted to tea fields and other plantations, which are notorious for the quantities of pesticides, weedicides and fertilizers they pour into the ecosystem so that we can enjoy our cup of tea. All over the world, amphibians are under dire threat from such pollution and are now considered our indicators and early warning devices of things going drastically wrong, thanks to our burgeoning population and mismanagement of the environment we depend on.

The Handbook contains brief chapters on breeding, metamorphosis, hibernation, distribution, threats and conservation. The text is simply written for everyone to understand and my only criticism is that a simple spell check should have been employed. Since one of the threats to the Himalayan salamander is the bio-supply trade for specimens to colleges, perhaps it is not a good idea to give details of localities where they are found.

The suggested conservation measures are all practical and should perhaps include the production of an attractive poster on the salamander, laminated for long life, that can be displayed in tea estates and other areas where people need to be aware of its uniqueness and vulnerability to adverse human activities.

The small book ends with 12 colour plates of maps, habitat and pictures of the salamander eggs, larvae, adults, behaviour and effects of pesticides. At Rs.250, the booklet is not likely to find a wide readership and the authors are encouraged to publish an inexpensive edition in Bengali and other eastern Indian languages, and perhaps think of some special status for our only salamander (how about 'State Amphibian'?).

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Venomous snakes of Africa

By Maik Dobiey and Gernot Vogel
2007. Edition Chimaira Buchhandlungsgesellschaft mbH,
Heddernheimer. Landstr. 20, D-60439 Frankfurt a. M. , Germany.
Telephone: (+49) (0) 69 49 72 23; Fax: (+49) (0) 69 49 78 26.
20 pp (text) + 128 pp (photographs). ISBN-13: 9783899733655. Price: 44.80 Euro.

This is the second volume in the Chimaira Terralog series on venomous snakes of the world and continues the same fine standard of the first volume. The text is again kept to a minimum with the focus being on clear pictorial presentation of the major species and subspecies of Africa's remarkable variety of venomous snakes.

How many of you knew that there are 32 species and subspecies of burrowing adders (asps) of the genus *Atractaspis* and how many of you have picked one up in the time-honoured thumb and forefinger 'safely' behind the head and been nailed by this sneaky little snake? Each species is given a clear photograph, most of them live in their natural habitat, but a some are wrinkled, preserved museum specimens in the authors' quest for complete coverage. Habitat photos and range maps make the book very useful as a field guide, especially for the new visitor to Africa, except for its large format, reducing portability.

Paging through the 18 species and subspecies of African cobras is a treat in itself, the snakes are magnificent and colours are out of this world. Similarly, seeing the 19 species of puff adders was an eye-opener, considering that we only have two common 'true' vipers on the whole subcontinent of India. What is also extremely useful is the photographic coverage of the different colour phases of Africa's venomous snakes, a fact of life that can make things very confusing if you are just getting familiar with the snakes of this continent.

All in all, Dobiey and Vogel's 'Venomous Snakes of Africa' is both a popular and a scholarly contribution to the herpetology of the African continent, and should find a place on the bookshelf of anyone interested in Africa's startling biodiversity.

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Jarujin Nabhitabhata

(1950–2008)

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(with one text-figure)

Figure 1. Jarujin Nabhitabhata (1950–2008). Photo: J. Murray (28 September 2006).

On 12 September 2008, Thailand suffered the loss of one of its greatest biodiversity specialists, Jarujin Nabhitabhata, Director of the Thailand Natural History Museum at the National Science Museum, and Editor of the Thailand Natural History Museum Journal, to a tragic medical accident, a heart attack induced by local anaesthetic administered for the removal of a mole which was supposed to be a minor medical procedure. His loss is a great one to southeast Asia's and Thailand's scientific community. Many biologists who have come to Thailand to do field work over the past decades came to know Jarujin Nabhitabhata because of the great assistance that he has given field researchers. He was a most genuinely friendly man and was always eager to discover new things.

Jarujin Nabhitabhata was born on 22 January 1950. He received his B.Sc. in 1972 and his M.Sc. in 1979 at Kasetsart University following elementary and high school at Vajiravudh College. He would later receive an honourary Ph.D. in Biology from Maha Sarakam University in 2004. In 1977, he received a certificate in Ectoparasite Biology from BIOTROP in Indonesia. From 1980 to 1981, Jarujin studied at the Deutsches Stiftung für Internationale Entwicklung, in the Federal Republic of Germany, where he received a certificate in Ecology and Taxonomy of Vertebrate Pests. His areas of expertise included ecology, biology, the taxonomy of vertebrates, particularly reptiles and amphibians, as well as considerable knowledge of bats and rodents, and the taxonomy of invertebrates, particularly butterflies and moths.

While Jarujin was a young student, he joined a pioneer group called the Association for the Conservation of Wildlife, under the leadership of Dr. Boonsong Lekagul (1907–1992), Thailand's premier conservationist and naturalist. This set the course of his life of service; one of his childhood friends recalled that he was familiar with the smell of chloroform from about the age of ten, after their collecting forays into the (long gone) clouds of butterflies in Bangkok, and added that he would not have received passing grades without Jarujin's homework assistance. After college, Jarujin spent four years working at the Association for the Conservation of Wildlife, doing field surveys during the preparation of Legakul and McNeely's monumental *Mammals of Thailand* (1977), and co-authored the ground breaking *Field Guide to the Butterflies of Thailand*, published the same year under the auspices of the Association. Later, he oversaw the Thai translation and update of Legakul and Round's *A Guide to the Birds of Thailand* released in 2007.

In 1976, Jarujin became staff entomologist in the Ecological Research Department of the Thailand Institute of Scientific and Technological Research, and curator of reptiles and amphibians in the National Reference Collection housed there. Large parts of this collection, combined with the many specimens remaining in Dr. Boonsong's estate, became the nucleus of the new Thailand Natural History Museum, which Jarujin helped establish in 1998 as Director of its Ecology and Environment Centre, and of which he was made overall Director in 2005. He once remarked that his proudest achievement was in preserving the legacy of Dr. Boonsong, which he did in many ways, not least the more than 130 popular and scientific books, articles, and papers he authored or co-authored in English and Thai.

Jarujin was instrumental in the conservation of endangered animals and plants in Thailand. He loved field work, and as a 'jack of all trades' was in constant demand. He oversaw and participated in extensive biodiversity surveys for the masterplans of at least eight important and many lesser known protected areas, as well as environmental impact assessments and a World Heritage nomination (for Huai Kha Khaeng – Thung Yai Wildlife Sanctuary). This long baseline experience of the Kingdom's fauna resulted in his guiding the IUCN Redlist process for evaluation of the conservation status of Thai mammals, reptiles and amphibians, published in 2005 as a volume of the Thailand Red Data Book, representing a lifetime of distribution and abundance records. He hosted the IUCN Global Amphibian Redlist process for all of south-east Asia in 2002. Jarujin began planning a *Field Guide to the Reptiles of Thailand* in the early 1980s, which was nearly complete, but unfortunately did not live to see its publication, expected in 2009.

Jarujin served on many bodies as diverse as the Royal Committee for Thai Language Scientific Nomenclature, the Birds and Bats Hazardous to Aviation at Chiang Mai, Hat Yai, and Bangkok International Airports, the board of the Bangkok Bird Club, and committees for numerous graduate students. He was widely admired for his public positions, ranging from opposition to the relaxation of protected area regulations to objecting to the Bangkok Metropolitan Authority's desire to have water monitors *(Varanus salvator)* moved out of the city. He was a member of the Royal Society of Thailand, and his funeral was presided over by Privy Councilor and former Prime Minister Gen. Surayud Chulanont. He will be missed.

Species co-described by Jarujin Nabhitabhata, comprising seven lizards, four amphibians and one beetle, all from Thailand (Duengkae et al., 2008):

- *Mantheyus phuwuaensis* (Manthey & Nabhitabhata, 1991) Phu Wua Lizard
- *Gekko taylori* Ota & Nabhitabhata, 1991 Taylor's Gecko
- *Echinoaesalus dharma* (Araya, Matsui, Nabhitabhata & Panha, 1994) Khao Luang Stag Beetle
- *Dibamus somsaki* Honda, Nabhitabhata, Ota & Hikida, 1997 Khao Soi Dao Snake Skink
- *Ansonia inthanon* Matsui, Nabhitabhata & Panha, 1998 Inthanon Stream Toad
- *Leptobrachium smithi* Matsui, Nabhitabhata & Panha, 1999 Smith's Litter Frog
- *Tropidophorus latisculatus* Hikida, Orlov, Nabhitabhata & Ota, 2002 Phu Wua Water Skink
- *Tropidophorus matsuii* Hikida, Orlov, Nabhitabhata & Ota, 2002 Roi-Et Water Skink
- *Tropidophorus murphyi* Hikida, Orlov, Nabhitabhata & Ota, 2002 Murphy's Water Skink
- *Tropidophorus hangnam* Chuaynkern, Nabhitabhata, Inthara, Kamsook & Somsri, 2005 Spiny-tailed Water Skink
- *Ansonia kraensis* Matsui, Khonsue & Nabhitabhata, 2005 Ranong Stream Toad
- *Amolops panhai* Matsui & Nabhitabhata, 2006 Somsak's Cascade Frog

Species named to date in honour of Jarujin Nabhitabhata (after Duengkae et al., 2008):

- *Liphistius jarujini* Ono, 1988 Jarujin's Spider
- *Cyrtodactylus jarujini* Ulber, 1993 Jarujin's Bent-toed Gecko
- *Potamon jarujini* Ng & Naiyanetr, 1993 Jarujin's Freshwater Crab

- *Paraboysidia nahbitabhatai* Panha & Burch, 2001 Nabhitabhata's Microsnail
- *Coniocompsa nabhitabhata* Sziraki, 2002 Nabhitabhata's Dusty-Wing
- *Rhacophorus jarujini* Matsui & Panha, 2006 Jarujin's Tree Frog
- *Platyroptilon jarujin* Papp, 2006 Jarujin's Fungus Gnat
- *Trichogalumna nabhitabhatai* Mahunka, 2008 Nabhitabhata's Mite

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*In 2000, Jarujin Nabhitabhata published 98 species accounts consisting of 253 pages in a series titled *Science for Juveniles: Interesting Animals* in volumes: Birds (1), Birds (2), Aquatic Animals, Wild Animals, and Animals of the World. Published by the Thailand Institute of Scientific and Technological Research, Bangkok. (in Thai.)

*From 2004 to 2008, Jarujin Nabhitabhata published 24 species accounts consisting of 48 pages in a series called *Hansa Nana Sat* ("Be delighted in various animals"). The first 14 were published by the National Science Museum and the last 10 were published by the National Science Museum and Thailand Natural History Museum.